MAC® 5000 resting ECG analysis system

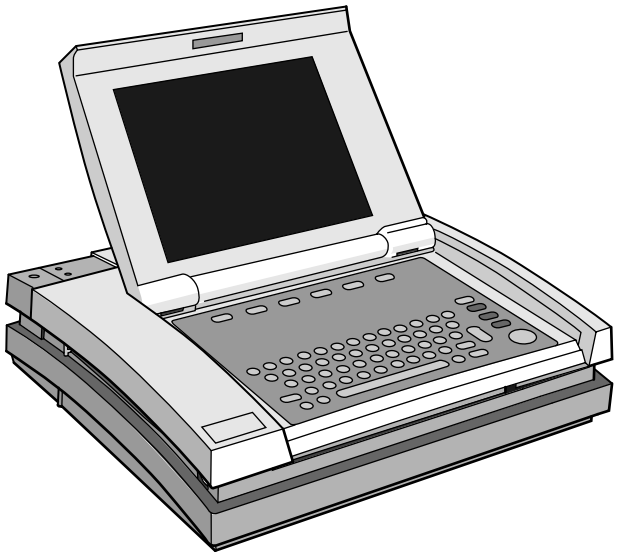
field service manual

PN 2000657-002 Revision A

MAC® 5000 resting ECG analysis system

field service manual

PN 2000657-002 Revision B



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NOTE

Due to continuing product innovation, specifications in this manual are subject to change without notice.

MD1322-018

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Manual Information

Revision History

Each page of the document has the document part number and revision letter at the bottom of the page. The revision letter identifies the document's update level.

The revision history of this document is summarized in the table below.

Table 1-1. Revision History PN 2000657-002

Revision	Date	Comment
A	27 August 1999	Initial release. Replaces pn 418625-002.
B	24 January 2000	Added Printhead Replacement procedure in Chapter 3. Added illustration and updated Diskette Drive Replacement in Chapter 3. Updated Chapters 6 & 7 with latest drawings.

Manual Purpose

This manual supplies technical information for service representative and technical personnel so they can maintain the equipment to the assembly level. Use it as a guide for maintenance and electrical repairs considered field repairable. Where necessary the manual identifies additional sources of relevant information and or technical assistance.

See the operator's manual for the instructions necessary to operate the equipment safely in accordance with its function and intended use.

Intended Audience

This manual is intended for the person who uses, maintains, or troubleshoots this equipment.

Conventions

Table 1-2. Styles	
Style	**Definition**
Black text	Indicates keys on the keyboard, text to be entered, or hardware items such as buttons or switches on the equipment.
Italicized text	Indicates software terms that identify menu items, buttons or options in various windows.
Ctrl+Esc	Indicates a keyboard operation. A (+) sign between between the names of two keys indicates, you press and hold the first key while pressing the second key once. For example, "Press **Ctrl+Esc**" means to press and hold down the **Ctrl** key while pressing the **Esc** key.
<**Space**>	Indicates that you must press the spacebar. When instructions are given for typing a precise text string with one or more spaces, the point where the spacebar must be pressed is indicated as: <**Space**>. The purpose of the < > brackets is to ensure you press the spacebar when required.
Enter	Indicates that you must press the "**Enter**" or "**Return**" key on the keyboard. Do not type "enter".

Safety Information

Definitions

⚠ DANGER — Indicates an imminently hazardous situation which, if not avoided, WILL result in death or serious injury.

⚠ WARNING — Indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

⚠ CAUTION — Indicates a potentially hazardous situation which, if not avoided may result in minor or moderate injury.

Messages

Additional safety messages may be found throughout this manual that provide appropriate safe operation information.

⚠ DANGER

Do NOT use in the presence of flammable anesthetics.

M15287-1B

⚠ WARNING

Operate the unit from its battery if the integrity of the protective earth conductor is in doubt.

M15287-14C

⚠ WARNING

This is Class I equipment. The mains plug must be connected to an appropriate power supply.

M15287-5C

⚠ CAUTION

U.S. Federal law restricts this device to sale by or on the order of a physician.

M15287-17B

⚠ CAUTION

This equipment contains no user serviceable parts. Refer servicing to qualified service personnel.

M15287-38A

Responsibility of the Manufacturer

GE Marquette Medical Systems is responsible for the effects of safety, reliability, and performance only if:

- Assembly operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by Marquette.
- The electrical installation of the relevant room complies with the requirements of the appropriate regulations.
- The equipment is used in accordance with the instructions for use.

General

The intended use of this device is to record ECG signals from surface ECG electrodes. This device can analyze, record, and store electrocardiographic information from adult and pediatric populations. This data can then be computer analyzed with various algorithms such as interpretive ECG and signal averaging for presentation to the user.

This device is intended for use under the direct supervision of a licensed health care practitioner.

Failure on the part of the responsible individual, hospital, or institution using this equipment to implement a satisfactory maintenance schedule may cause undue equipment failure and possible health hazards.

To ensure patient safety, use only parts and accessories manufactured or recommended by GE Marquette Medical Systems.

Contact GE Marquette Medical Systems for information before connecting any devices to this equipment that are not recommended in this manual.

If the installation of this equipment, in the USA, will use 240 V rather than 120 V, the source must be a center-tapped, 240 V, single-phase circuit.

Parts and accessories used must meet the requirements of the applicable IEC 601 series safety standards, and/or the system configuration must meet the requirements of the IEC 601-1-1 medical electrical systems standard.

The use of ACCESSORY equipment not complying with the equivalent safety requirements of this equipment may lead to a reduced level of safety of the resulting system. Consideration relating to the choice shall include:

- use of the accessory in the PATIENT VICINITY; and
- evidence that the safety certification of the ACCESSORY has been performed in accordance to the appropriate IEC 601-1 and/or IEC 601-1-1 harmonized national standard.

Equipment Symbols

The following symbols appear on the equipment.

Type B equipment.

Type BF equipment, external defibrillator protected.

Alternating current. When illuminated, the green LED next to this symbol indicates AC power is connected.

Equipotential.

Charge the battery. The flashing amber LED next to this symbol indicates you must connect the system to AC power to re-charge the battery.

DO NOT throw the battery into the garbage.

Recycle the battery.

Consult accompanying documents.

Classified with respect to electric shock, fire, mechanical, and other specified hazards only in accordance with UL 2601-1, CAN/CSA C22.2 No. 601-1, CAN/CSA C22.2 601-2-25, EN 60601-2-25, EN 60601-1-1.

In Europe, this symbol means dangerous or high voltage. In the United States, this symbol represents the caution notice below:

⚠ CAUTION

To reduce the risk of electric shock, do NOT remove cover (or back). Refer servicing to qualified personnel.

M15287-16A

MD1325-097A, -098A, -096A, -108A, -101A, -102A, -103A, -100A, -181A, -099A

Service Information

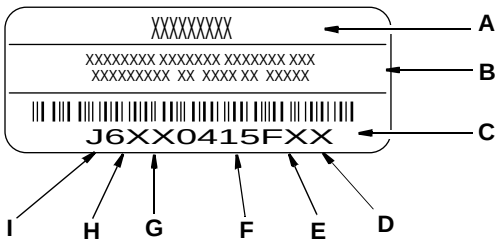
Service Requirements

Refer equipment servicing to GE Marquette Medical System's authorized service personnel only. Any unauthorized attempt to repair equipment under warranty voids that warranty.

It is the user's responsibility to report the need for service to GE Marquette Medical Systems or to one of their authorized agents.

Equipment Identification

Every GE Marquette Medical Systems device has a unique serial number for identification. The serial number appears on the product label on the base of each unit.



MD1113-022C

Table 1-3. Equipment Identifications

Item	Name	Description
A	name of device	MAC 5000 resting ECG analysis system
B	manufacturer	GE Marquette Medical Systems, Inc.
C	serial number	Unique identifier
D	device characteristics	One or two letters that further describe the unit, for example: P = prototype not conforming to marketing specification; R = refurbished equipment; S = special product documented under Specials part numbers; U = upgraded unit
E	division	F = Cardiology G = Monitoring J = GW Labs
F	product sequence number	Manufacturing number (of total units manufactured)
G	product code	Two-character product descriptor MH = MAC 5000 resting ECG analysis system
H	year manufactured	9 = 1999, 0 = 2000, 1 = 2001, (and so on)
I	month manufactured	A = January, B = February, C = March, D = April, E = May, F = June, G = July, H = August, J = September, K = October, L = November, M = December

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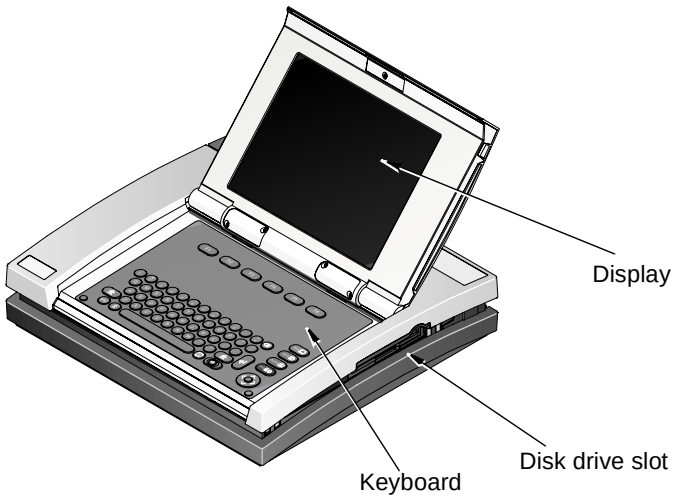
General Description

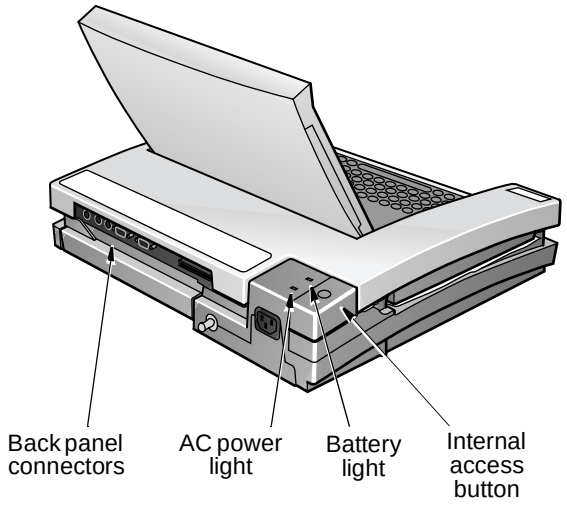
The MAC 5000 resting ECG analysis system is a 15 lead, 12 channel system with a 10.4 inch (264 mm) diagonal display, active patient cable, battery operation, and late potential electrocardiography. There are also options for wireless communication, vector, and network capabilities.

Front View



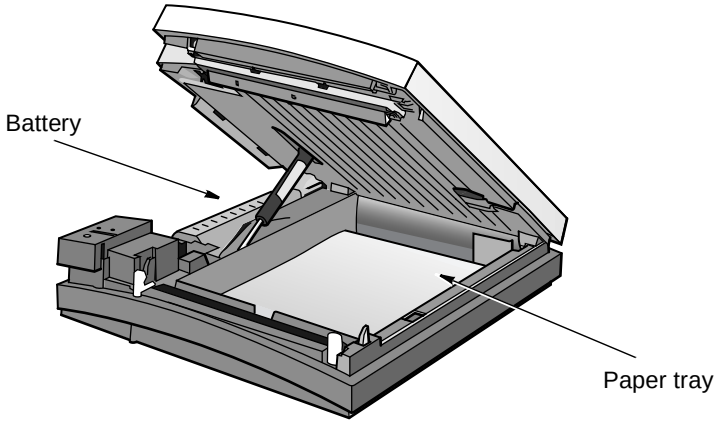
MD1325-115A

Back View



MD1325-117A

Internal View

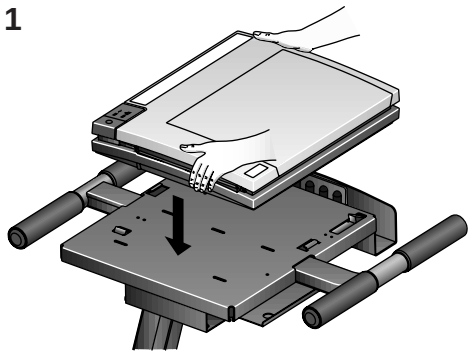


MD1325-116A

Preparation for Use

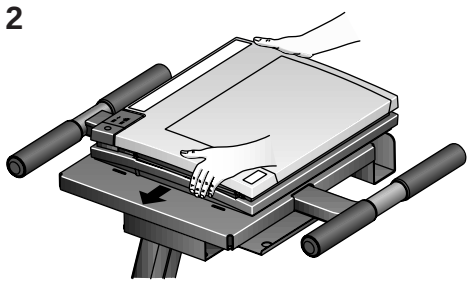
Trolley Assembly

1. Mount the unit to the optional trolley by lining up the left edge of the unit to the two slots at the left edge of the trolley.



MD1325-171A

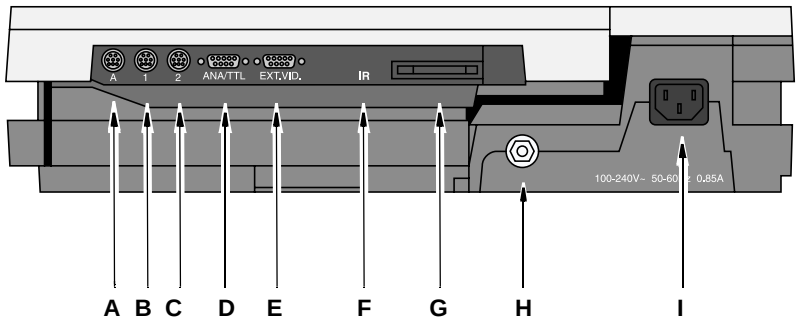
2. Place the unit on the trolley surface, then slide it to the left until the tabs click and the unit is firmly in place on the trolley.



MD1325-172A

3. From under the trolley, tighten two captive screws.

Connector Identification



MD1325-118A

Table 2-1. Back Panel Connectors

Item	Name	Description
A	**A**	Not functional.
B	**1**	Connect a Marquette KISS pump (optional).
C	**2**	Connect a local transmission cable, serial line, Marquette KISS pump, or external modem (optional).
D	**ANA/TTL**	Connect a device requiring analog data or TTL trigger.
E	**EXT.VID.**	Connect an external video display.
F	**IR**	Point at a MAC 5000 or MUSE CV system's **IR** transceiver to transmit or receive ECG data.
G	card slot	Insert the software card into this slot to run the system.
H	ground lug	Connect non-grounded peripheral devices to ensure equipotential.
I	mains AC power	Insert the mains AC power cable.

⚠WARNING

Keep leakage current within acceptable limits when connecting auxiliary equipment to this device.

M15287-7C

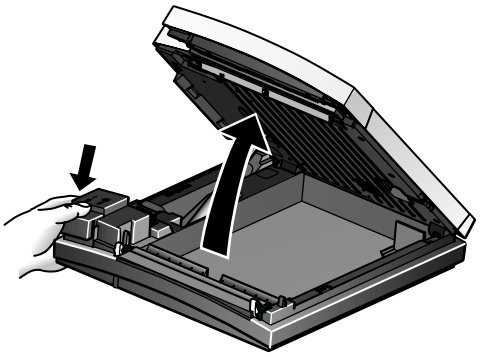
⚠WARNING

Total system leakage current must not exceed 100 microamperes.

M15287-9D

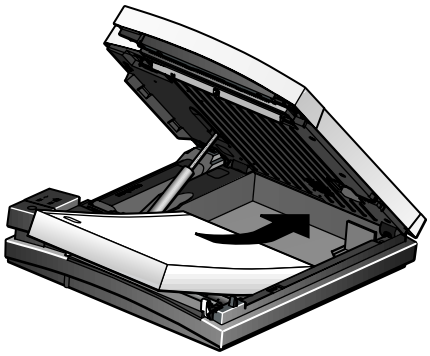
Paper Installation

1. Press the internal access button to open the unit.



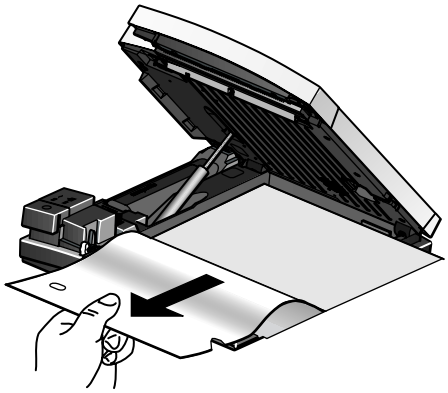
MD1325-092B

2. Slide a stack of paper into the writer compartment with the paper cue hole toward the internal access button.



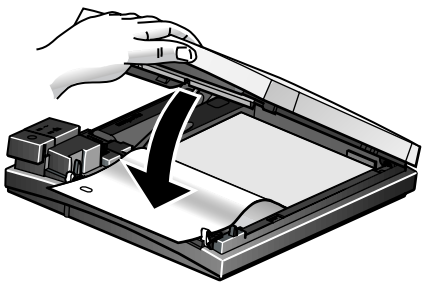
MD1325-093B

3. Pull out the top sheet of paper from the stack.



MD1325-094B

4. Close the unit.



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Controls and Indicators

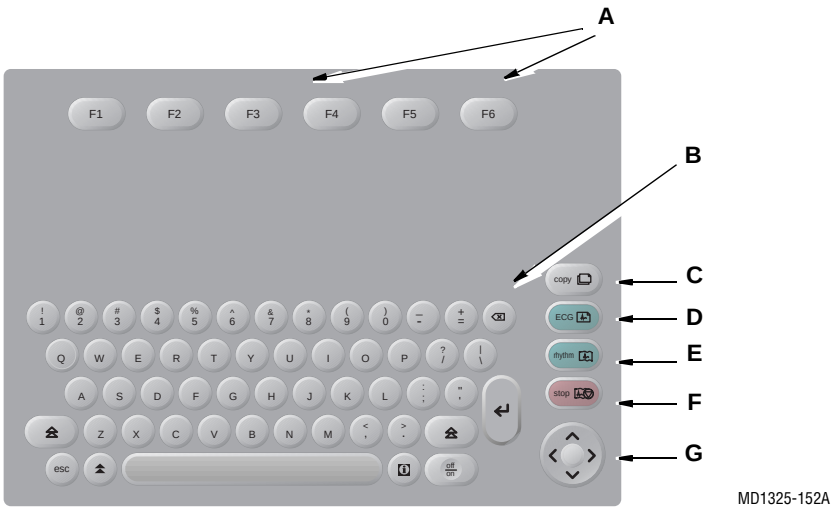

Table 2-2. Keypad		
Item	**Name**	**Description**
A	function keys	Selects screen menu functions
B	**delete**	Erases typed characters
C	**copy**	Prints another ECG report
D	**ECG**	Acquires an ECG
E	**rhythm**	Prints continuous ECG data (This data cannot be stored or transmitted.)
F	**stop**	Stops the writer from printing
G	arrow pad	Moves the cursor left, right, up, down and selects a highlighted menu or screen item.

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Introduction

Recommended Maintenance

Regular maintenance, irrespective of usage, is essential to ensure that the equipment will always be functional when required.

> **NOTE**
>
> Unless you have an Equipment Maintenance Contract, GE Marquette Medical Systems does not in any manner assume the responsibility for performing the recommended maintenance procedures. The sole responsibility rests with the individual or institution using the equipment. GE Marquette Medical Systems service personnel may, at their discretion, follow the procedures provided in this manual as a guide during visits to the equipment site.

Preventive Maintenance Inspection Report

To help you establish a systematic maintenance routine, GE Marquette Medical Systems recommends that, every six months, you perform the maintenance checks and test procedures on the "Preventive Maintenance Inspection Report," included at the end of this chapter.

Required Tools and Supplies

In addition to a standard set of hand tools, you will need the items listed below.

Table 3-1. Tools and Supplies

Item	Part Number
#10 TORX driver	
Leakage current tester	MT-1216-02AAMI (for 220V) MT-1216-01AAMI (for 110V)
Multifunction micro-simulator	MARQ 1
Precision dust remover	
Lint-free soft cloth	TX609

Inspection and Cleaning

Visual Inspection

Perform a visual inspection of all equipment and peripheral devices daily. Turn off the unit and remove power before making an inspection or cleaning the unit.

- Check the case and display screen for cracks or other damage.
- Regularly inspect all cords and cables for fraying or other damage.
- Verify that all cords and connectors are securely seated.
- Inspect keys and controls for proper operation.
  - Toggle keys should not stick in one position.
  - Knobs should rotate fully in both directions.

Exterior Cleaning

Clean the exterior surfaces monthly, or more frequently if needed.

1. Use a clean, soft cloth and a mild dishwashing detergent diluted in water.
2. Wring the excess water from the cloth. Do not drip water or any liquid on the equipment, and avoid contact with open vents, plugs, or connectors.
3. Dry the surfaces with a clean cloth or paper towel.

Interior Cleaning

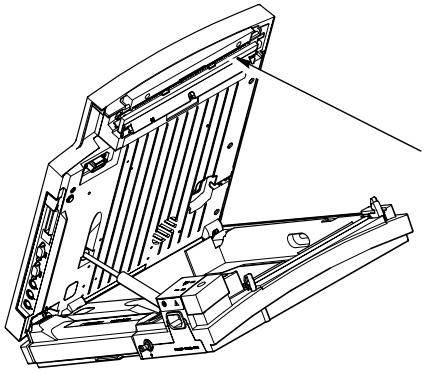
General

Check for dust buildup on the surfaces of the interior circuit boards, components, and power supply. Use commercially available compressed air to blow away the accumulated dust. Follow the manufacturers directions.

Thermal Printhead

Clean the thermal printhead every three months or more often with heavy use. A build-up of thermal paper coating on the printhead can cause light or uneven printing.

Use a solution containing alcohol on a nonwoven, nonabrasive cloth such as Techni-Cloth to wipe off the printhead. Do not use paper toweling, as it can scratch the printhead.

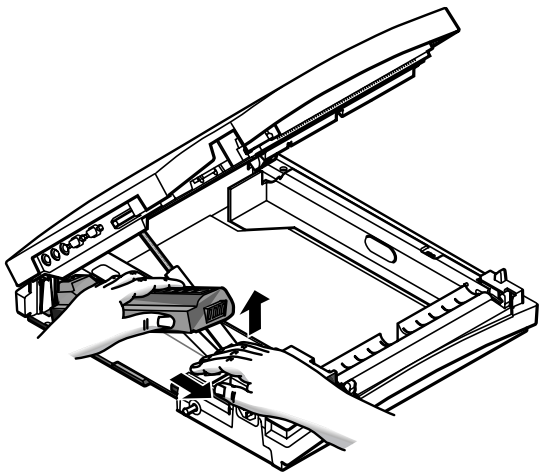


MD1322-004A

Battery and Patient Cable Replacement

Battery Replacement

1. Press the internal access button to open the unit.
2. Slide the battery release button in the direction of the arrow and lift the battery out.

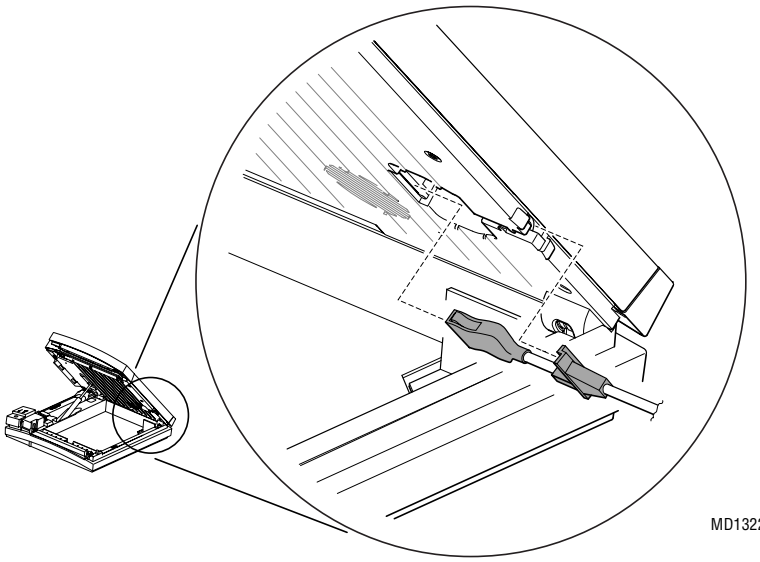


MD1325-112B

3. Install a new battery and close the unit.

Patient Cable Replacement

1. Press the internal access button to open the unit.
2. Press connector release tabs and pull the connector loose.
3. Pull the cable from the retaining tabs.



MD1322-006

4. Reassemble the cable by reversing the above steps.

Disassembly Guidelines

Preliminary Steps

Prior to disassembly, perform the following:

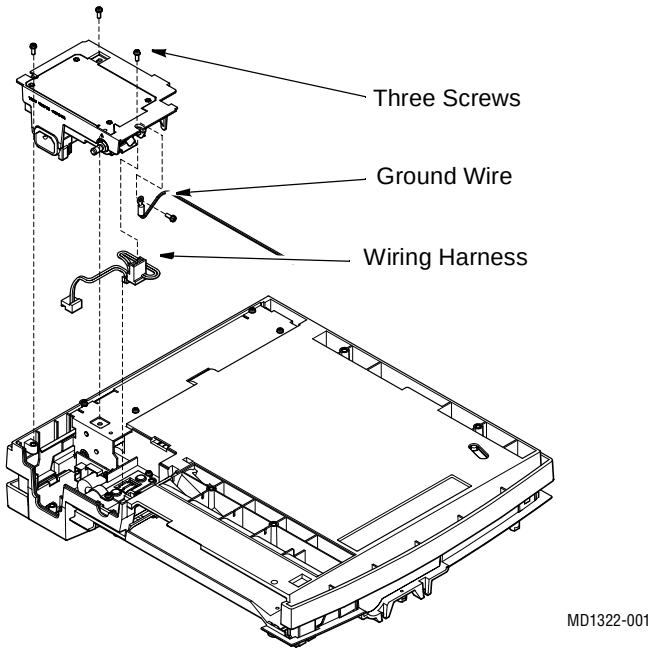
- If possible, process any ECGs remaining in storage.
- If possible, print out set-up for future reference.
- Disconnect the unit from the AC wall outlet and remove the power cord from the unit.
- Remove the battery.
- Remove the chart paper.
- Take strict precautions against electrostatic discharge damage.

> **NOTE**
>
> A #10 TORX driver is required for disassembly and assembly.

Power Supply

Removal

1. Turn the unit over so the bottom side is up.
2. Using a #10 TORX driver, remove the three screws holding the power supply in place.
3. Lift the power supply to expose the wiring harness and ground wire.
4. Remove P2 from J2 on the power supply assembly and the ground wire connection from the power supply chassis.



Reassembly

Reassemble the power supply reversing the steps for removal. Before replacing the screws, ensure that the ground wire is routed through the notch in the plastic and not pinched.

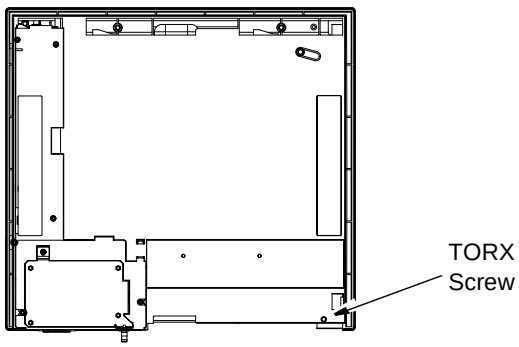
Top Cover

Removal

NOTE

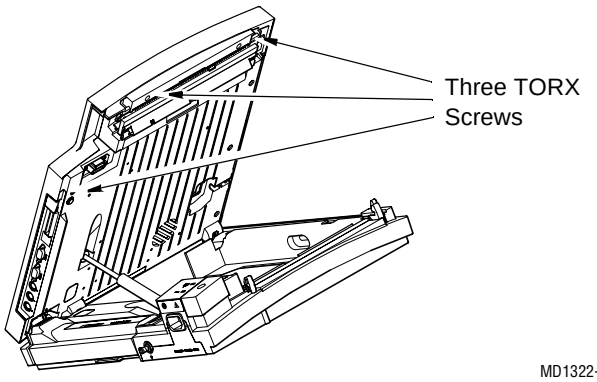
It is not necessary to remove the power supply prior to removing the top cover.

1. Turn the unit over so the bottom side is up and remove the TORX screw through the hole on the right rear corner of the unit. (This screw is only visible and accessible with the battery removed.)



MD1322-002

2. Turn the unit right side up and press the internal access button and raise the top of the unit.
3. Remove three TORX screws.



MD1322-004A

4. Lower the top of the unit and lock in place.
5. Raise the display to the vertical position.

6. Gently lift the rear of the top cover free from the unit.

> **NOTE**
>
> The top cover holds the bezel that surrounds the rear panel connectors, so the bezel may fall free at this time.

7. At the front of the top cover, gently pull the thin strip of plastic free from under the keyboard. The entire top assembly is now loose.

> **NOTE**
>
> It may be helpful to rotate the top cover 45 degrees to provide a larger opening to clear the display.

8. Carefully lift the top assembly up and clear of the raised display.

Reassembly

1. Raise the display to the vertical position.
2. Make sure the bezel surrounding the rear panel connectors is in place. Make sure the release mechanism for the Smartmedia card functions properly.
3. Lower the top cover down around the display and set in position.
4. Snap the rear of the top cover in place and then, gently pulling on the thin plastic strip at the front of the top cover, position it in place under the keyboard assembly.
5. Replace the screws removed in disassembly.

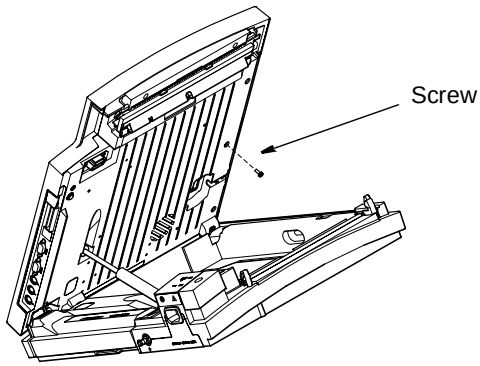
Display/Keyboard Assembly

Removal

1. Remove the top cover following the procedures above.
2. Label the three cables connecting the display/keyboard assembly to the main PCB. Disconnect these cables from the main PCB.

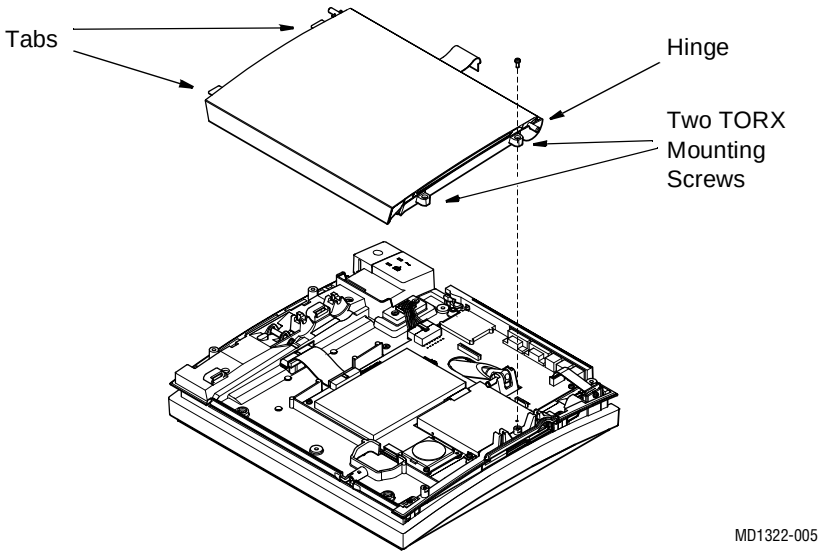
> **NOTE**
>
> Two of these cables have locked connectors that must be lifted up to release the cables.

3. Press the internal access button and raise the top of the unit. Remove one screw on the inside, near the front edge of the top.



MD1322-004B

4. Working from the outside of the top, remove the two TORX mounting screws located on the right side of the assembly.
5. Slide the display hinge (metal rod) to the left to release it from the mounting detent.



MD1322-005

6. Slightly lift up on the right hand side of the display/keyboard assembly, and pull the assembly to the right to free the tabs from their mounting slots. Do not lift the right side of the display too high or the plastic tabs may be damaged.
7. When free from the main unit, the display/keyboard assembly can be separated in to two pieces allowing replacement of either the keyboard or display assembly.

NOTE

Further disassembly of the LCD assembly is not recommended. Replace as a complete assembly.

Reassembly

1. Slide tabs into their mounting slots and set the display/keyboard assembly in place.
2. Replace the two TORX mounting screws on the right side of assembly.
3. Slide the display hinge (metal rod) to the right until it snaps into the mounting detent.
4. Connect the three cables from the display/keyboard assembly to the main PCB. Be sure to lift the locks up prior to attempting to insert the cables into the connectors.

Main PCB

Removal

1. Remove the top cover and display/keyboard assemblies following the procedures above.
2. Disconnect all remaining cable connections to the main PCB. These include cables to the
   - power supply
   - printhead
   - battery connect PCB
   - diskette drive
3. Remove the mounting screws holding the main PCB in place. They are located around the outside edges of the main PCB.
4. Lift the main PCB from the unit.

Reassembly

1. Reassemble the main PCB reversing the steps for removal.
2. Install the battery and paper, then power on the unit and verify that the
   - serial number and printhead resistance (label on printhead) is correct
   - setup parameters meet user's requirements.

Printhead Replacement

Removal

1. Remove the top cover and display/keyboard assemblies following the procedures above.
2. Using a Phillips head screw driver, remove the two screws that hold the printhead to the metal roller assembly.
3. Open the writer assembly, disconnect and remove the printhead.

Reassembly

1. Record the resistance value of the new printhead.
2. Connect the new printhead to the ribbon cable.
3. Hold the new printhead FIRMLY in place against the two metal tabs on the roller assembly, then tighten the two screws.

4. replace the top cover and power up the unit.
5. Go to the Setup menu and enter the new printhead resistance value.
6. Do a Writer Daignostics test (See 4-19).

Diskette Drive Removal/ Replacement

1. Remove the top cover and display/keyboard assembly following the procedures above.
2. Remove the cable from the diskette drive to the main PCB.
3. Remove two screws holding the diskette drive in place. Loosen, but do not remove two TORX mounting screws holding the mounting bracket.
4. Detach the diskette drive and lift from the unit.
5. Apply the adhesive pad to the replacement diskette drive and position the drive in the unit. Insert and loosely attach the two screws.
6. The mounting screws MUST be tightened in the following order:
   - Tighten the two TORX mounting screws,
   - then tighten the two screws holding the drive to the mounting bracket.
7. Connect cable to the main PCB.
8. Replace the display/keyboard assembly and the top cover following procedures above.

Writer Roller/Carriage Assembly

Removal

1. Remove the power supply assembly following procedures above.
2. Inside the power supply compartment, disconnect the cable that connects to the writer assembly.
3. Open the unit to access the paper compartment. Move the paper size bracket to the A4 position to expose one of the writer assembly mounting screws.
4. Remove the screw and return the paper size bracket to the 8.5 x 11 position.
5. Close the unit and turn it over so the bottom side is up.
6. Remove the four screws located on the underside of the writer roller/carriage assembly and lift the writer from the bottom of the unit.

Reassembly

Reassemble the writer roller/carriage assembly by reversing the above procedures.

Domestic Electrical Safety Tests

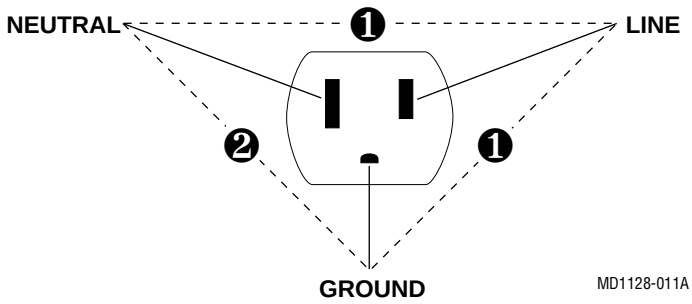
AC Line Voltage Test

This test verifies that the domestic wall outlet supplying power to the equipment is properly wired. For international wiring tests, refer to the internal standards agencies of that particular country.

120 VAC, 50/60 Hz

Use a digital voltmeter to check the voltages of the 120-volt AC wall outlet (dedicated circuit recommended). If the measurements are significantly out of range, have a qualified electrician repair the outlet. The voltage measurements should be as follows:

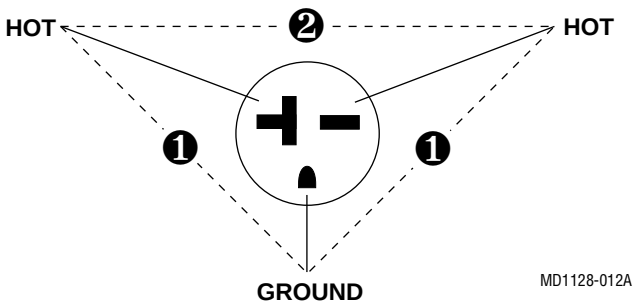
1. 120 VAC (± 10 VAC) between the line contact and neutral and between the line contact and ground.
2. Less than 3 VAC between neutral and ground.



240 VAC, 50/60 Hz

Use a digital voltmeter, set to measure at least 300 VAC, to check the voltages of the NEMA 6-20R, AC wall outlet (dedicated circuit recommended). If the measurements are significantly out of range, have a qualified electrician repair the outlet. The voltage measurements should be as follows:

1. 120 VAC (± 10 VAC) between either “hot” contact and ground.
2. 210 to 230 VAC between the two “hot” contacts.



Leakage Tests

The leakage tests are safety tests to ensure that the equipment poses no electrical health hazards. Use the table below to determine which tests apply to the unit under test and the maximum allowable leakage currents. For international leakage limits, refer to the internal standards agencies of that particular country.

If the unit under test fails the leakage tests, do not allow the customer to use the equipment. Call Tech Support for assistance. (See the "How to Reach Us" page in the front of the manual.)

GE Marquette Medical Systems recommends that you perform these tests:

- Before applying power for the first time
- Every 6 months as part of routine maintenance
- Whenever internal assemblies are serviced

NOTE

The accuracy of the leakage tests depends on a properly-wired wall outlet. Do not proceed until you verify the integrity of the power source.

⚠WARNING

Total system leakage current must not exceed 300 microamperes.

M15287-76A

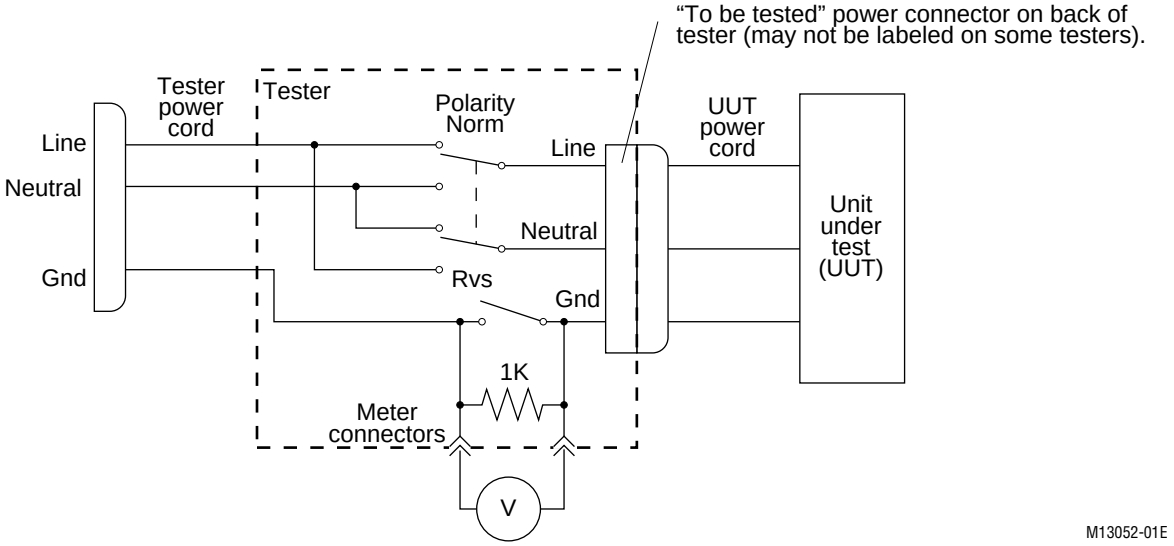
Table 3-2. Leakage Tests and Maximum Allowable Leakage Currents

Test	Maximum Current (μA)
1 Ground-wire-leakage-to-ground	300
2 Chassis-leakage-to-ground	300
3 Patient-cable-leakage-to-ground	10
4 Patient-cable-leakage-into-patient-leads-from-120 V ac	20

Leakage Test Diagrams

These diagrams show only a representation of how a typical leakage current tester functions. Follow the instructions provided with the leakage current tester that you use.

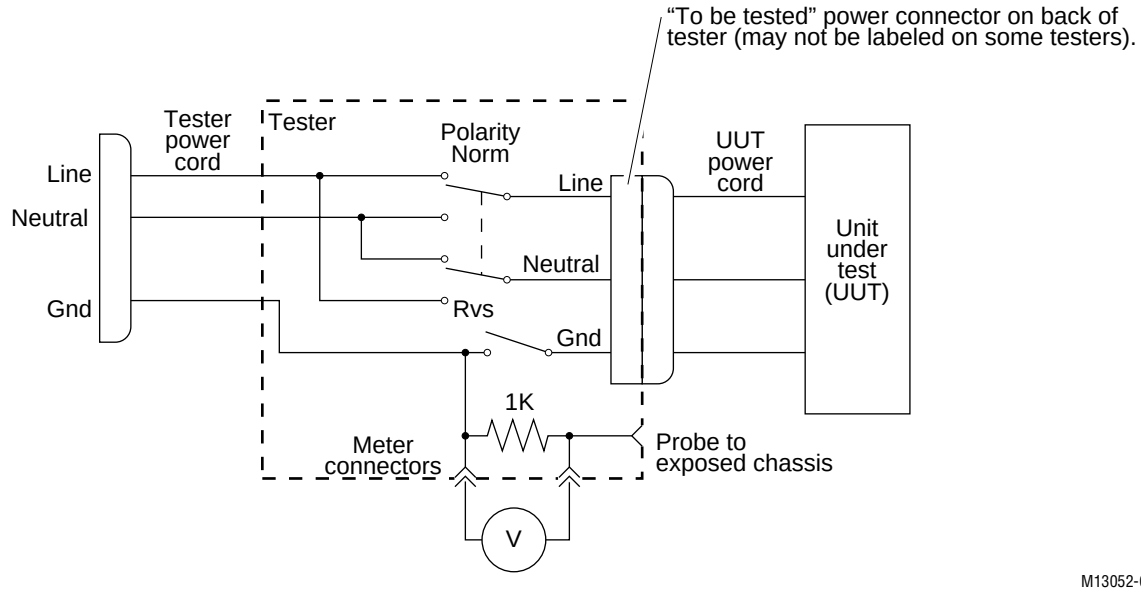
Test #1 Ground-wire-leakage-to-ground



M13052-01E

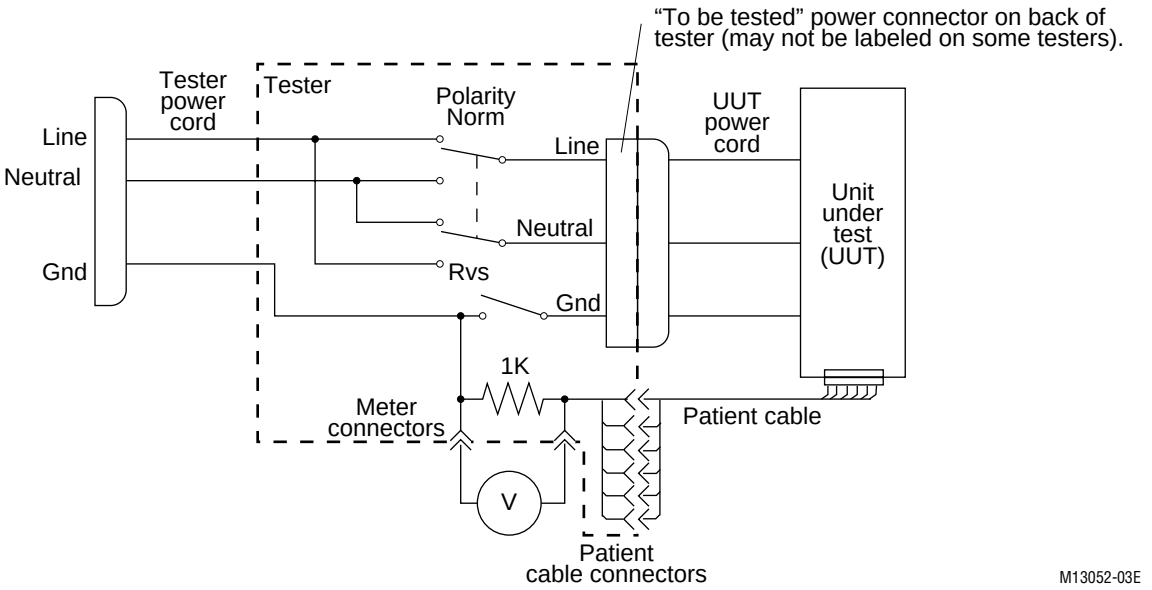
Test #2 Chassis-leakage-to-ground

Apply line voltage to the UUT chassis for this test.



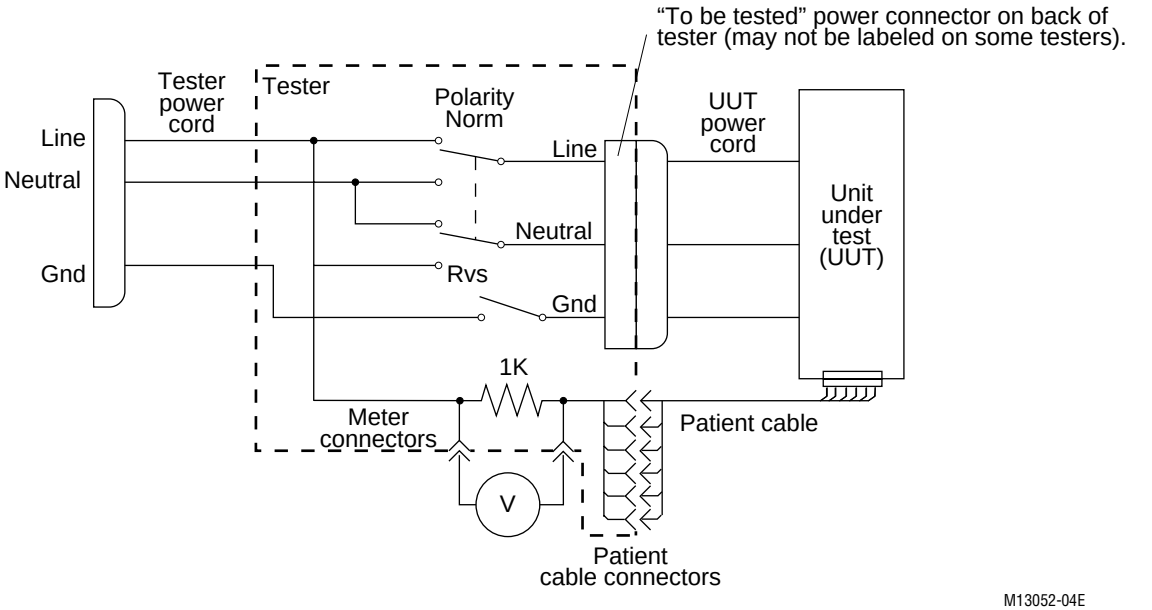
M13052-02E

Test #3 Patient-cable-leakage-to-ground



Test #4 Patient-cable-leakage-into-patient Leads-from 120 VAC

During this test, line voltage is applied to the patient cable connectors. To prevent erroneous readings, do not allow the leadwires to contact conductive materials such as metal handles, and do not place the leadwires on the floor.



Ground Continuity

This test verifies that there is continuity (less than 100 mΩ resistance) between all the exposed metal surfaces, which have the potential to become energized, and the ground prong on the mains AC power cord. If the metal surfaces are anodized or painted, scrape off a small area in an inconspicuous area for the probe to make contact with the metal.

- Use a digital multimeter to check ground continuity from the AC line cord ground pin to exposed metal surfaces. (i.e. rear panel ground lug, ANA/TTL, and EXT. VID.)
- If the measurements are significantly out of range, check for breaks in the power cord or in the internal connections within the unit.

Preventive Maintenance

GE Marquette Medical Systems recommends that every six months you perform the maintenance checks and test procedures on the "Preventive Maintenance Inspection Report". These maintenance procedures can be performed more often if indicated. Contact GE Marquette Service for the latest preventive maintenance procedures for this product.

4 Troubleshooting

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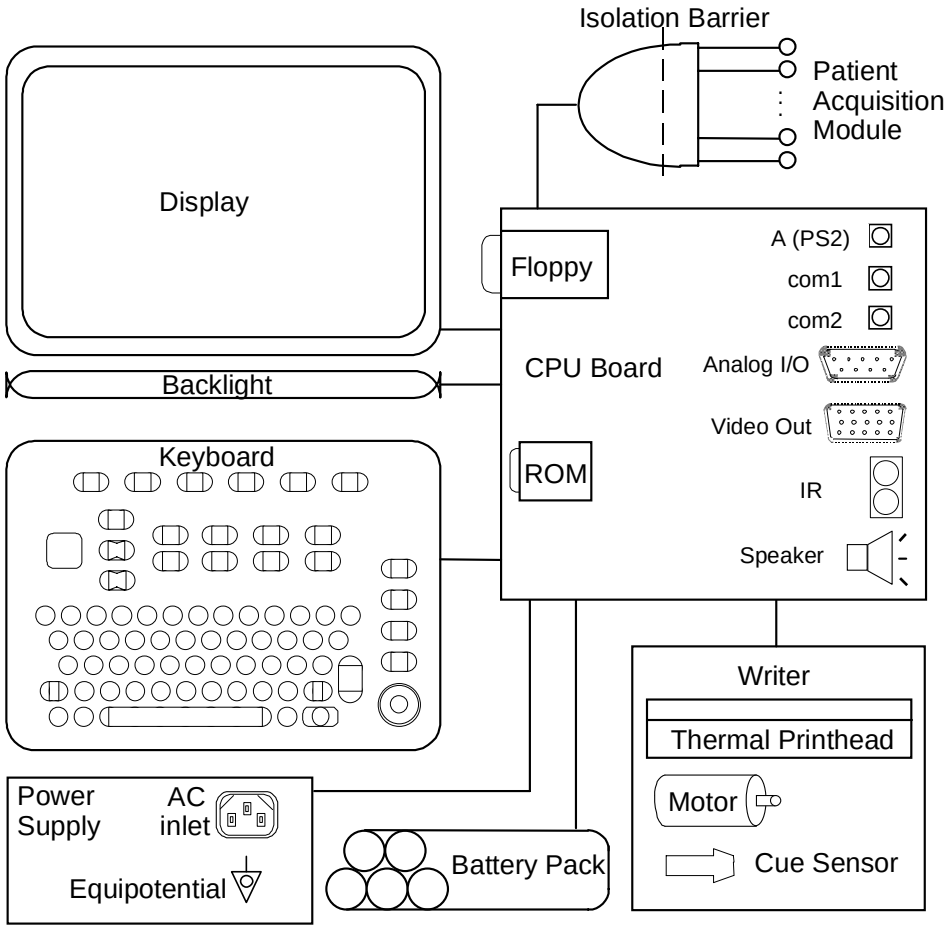
Assembly Descriptions

Introduction

The troubleshooting information in this chapter helps you narrow service problems to one of the replaceable assemblies. These assemblies, illustrated in the block diagram, are discussed in more detail in the individual assembly chapters along with replacement procedures.

Assembly Block Diagram



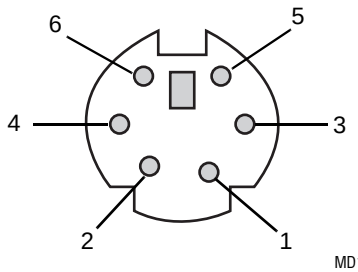
Input and Output Connectors

The pin-by-pin descriptions identify the signal names and pin outs for each connector on the unit.

A Pins (J1)

Table 4-1. A (J1)

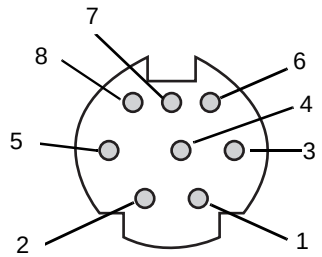
Pin	Name
1	Data
2	NC
3	Ground
4	+5V
5	Clock
6	NC



COM1 (COM3/4) Pins (J3)

Table 4-2. COM1 (J3)

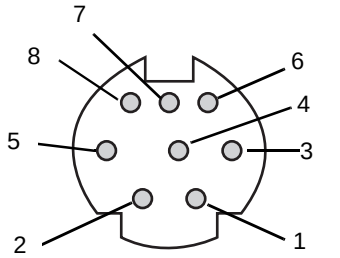
Pin	COM1 Signal	COM3/4 Signal
1	RTS	COM3 TxD
2	CTS	COM3 RxD
3	TxD	
4	Ground	
5	RxD	
6	DTR	COM4 TxD
7	+12V	
8	DSR	COM4 RxD



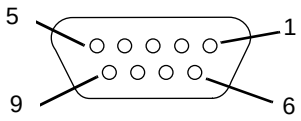
COM2 Pins (J5)

Table 4-3. COM2 (J5)

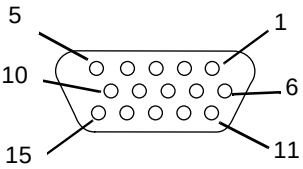
Pin	Name
1	RTS
2	CTS
3	TxD
4	Ground
5	RxD
6	DTR
7	+12V
8	DSR



ANALOG Pins (J6)

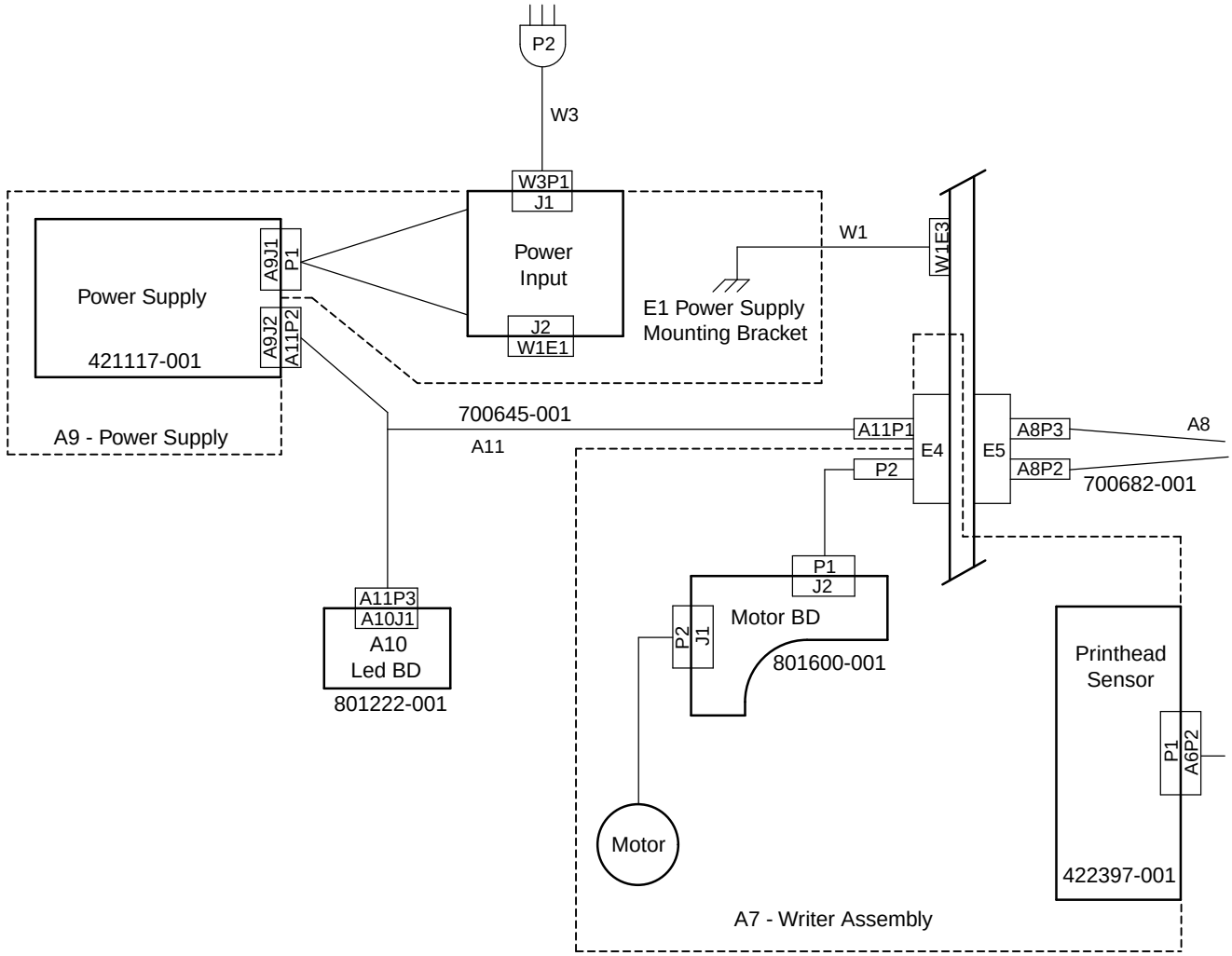
Table 4-4. Acquisition Module Connector (J4)		
Pin	**Name**	
1	+12V	 MD1322-010
2	DC Output 1	
3	TTL Trigger Output	
4	Ground	
5	Ground	
6	DC Output 2	
7	DC Input 1	
8	ECG Output	
9	DC Input 2	

EXT. VID. Pins (J7)

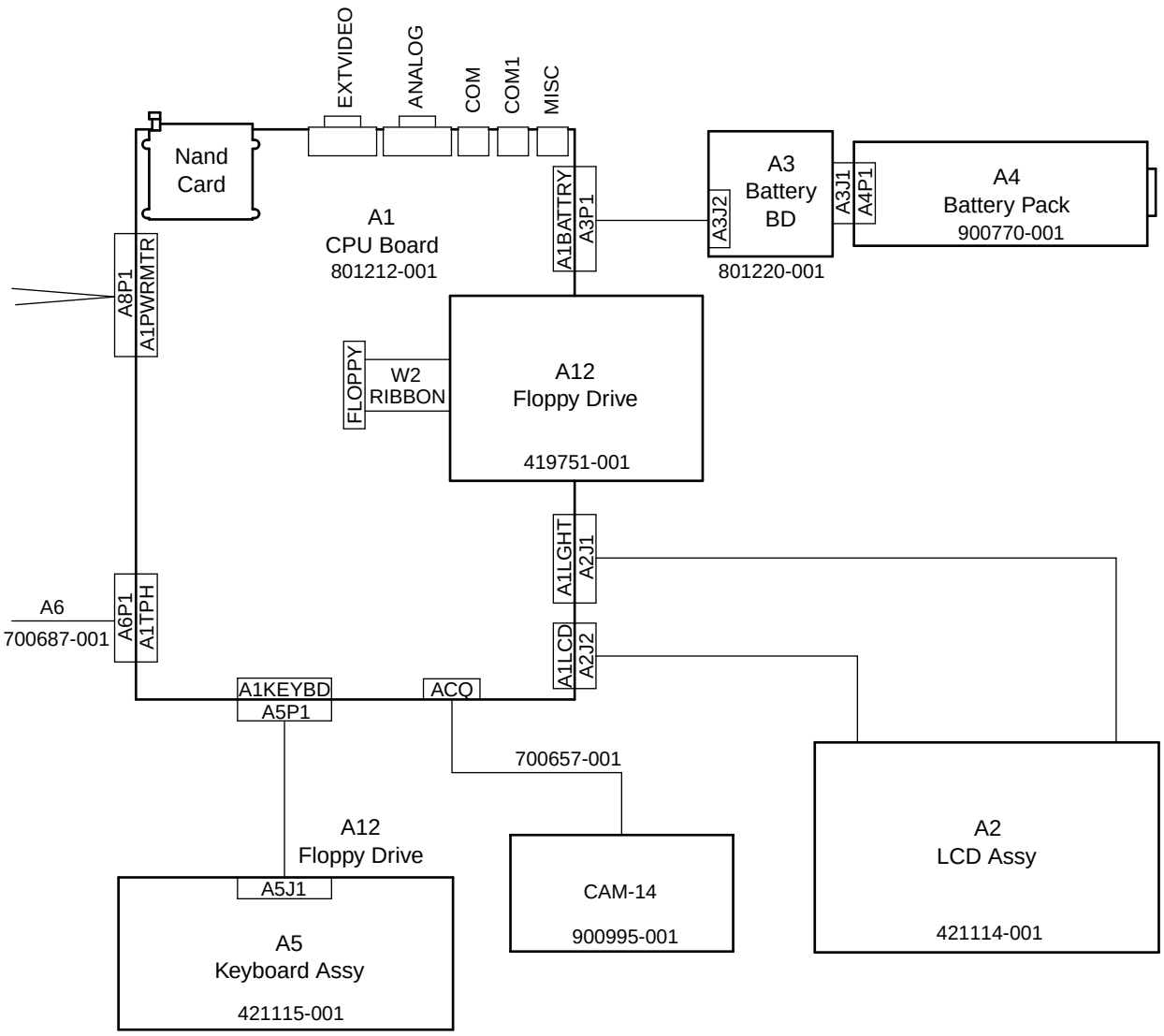
Table 4-5. External VGA Video (J7)		
Pin	**Name**	
1	Red Video	 MD1322-009
2	Green Video	
3	Blue Video	
4	Ground	
5	Ground	
6	Ground	
7	Ground	
8	Ground	
9	NC	
10	Ground	
11	Ground	
12	NC	
13	Horizontal Sync	
14	Vertical Sync	
15	NC	

Internal Cabling

This diagram shows the cables and connectors for the assemblies in the unit. The following pages detail the input/output signals for those connectors.



MD1322-015L


EXTVIDEO
ANALOG
COM
COM1
MISC
Nand Card
A1
CPU Board
801212-001
A1BATTRY
A3P1
A3
Battery BD
A3J2
801220-001
A3J1
A4P1
A4
Battery Pack
900770-001
A8P1
A1PWRMTR
FLOPPY
W2
RIBBON
A12
Floppy Drive
419751-001
A1LGHT
A2J1
A6
700687-001
A6P1
A1TPH
A1LCD
A2J2
A1KEYBD
A5P1
ACQ
700657-001
A12
Floppy Drive
A5J1
A5
Keyboard Assy
421115-001
CAM-14
900995-001
A2
LCD Assy
421114-001

MD1322-016R

CPU PCB Input/Output Signals

Battery Pack/Monitor (J2)

Pin No.	Signal
1	18V Battery Power
2	18V Battery Power
3	Battery Temperature Sense
4	3V Temperature Sense Power
5	Battery Ground
6	Battery Ground

LCD Backlight (J4)

Pin No.	Signal
1	12V Power
2	12V Power
3	12V Power
4	Ground
5	Ground
6	Brightness Select
7	Backlight Enable
8	NC
9	Ground
10	Ground

Keyboard (J8)

Pin No.	Signal
1	NC
2	NC
3	NC
4	NC
5	NC
6	Sense4
7	Sense2
8	Sense1
9	Sense0
10	Sense3
11	Sense5
12	Sense6
13	Sense7
14	Drive0
15	Drive1
16	Drive2
17	Drive3
18	Drive4
19	Ground
20	Power Key
21	Drive5
22	Drive6
23	Drive7
24	Drive8
25	Drive9
26	Drive10

LCD (J10)

Pin No.	Signal
1	Ground
2	Pixel Clock
3	Hsync
4	Vsync
5	Ground
6	R0 (LSB)
7	R1
8	R2
9	R3
10	R4
11	R5 (MSB)
12	Ground
13	G0 (LSB)
14	G1
15	G2
16	G3
17	G4
18	G5 (MSB)
19	Ground
20	B0 (LSB)
21	B1
22	B2
23	B3
24	B4
25	B5 (MSB)
26	Ground
27	Data Enable
28	3V Power
29	3V Power
30	NC
31	NC

Power Supply/Motor (J11)

Pin No.	Signal
1	Motor Encoder B
2	5V Power
3	Motor A
4	Motor Encoder A
5	Ground
6	Motor B
7	NC
8	28V Power
9	Ground
10	Battery Charge LED
11	28V Power
12	Ground
13	Door Open Detect
14	Ground

Thermal Printer (J12)

Pin No.	Signal
1	Thermal Printer Power
2	Thermal Printer Power
3	Thermal Printer Power
4	Thermal Printer Power
5	Thermal Printer Power
6	Thermal Printer Power
7	Thermal Printer Power
8	Ground
9	Ground
10	Ground
11	Ground
12	Ground
13	Ground
14	Ground
15	Cue Sense
16	NC
17	5V Main Power
18	Ground
19	Data Strobe
20	Data Strobe
21	Data Strobe
22	Data Strobe
23	Data Load
24	Data Clock
25	Print Head Temperature
26	Pixel Data

Floppy Disk Drive (J13)

Pin No.	Signal
1	5V Power
2	Index
3	5V Power
4	Drive Select 0
5	5V Power
6	Disk Change
7	NC
8	Media Sense 0
9	Media Sense 1
10	Motor Select 0
11	NC
12	Direction
13	NC
14	Step
15	Ground
16	Write Data
17	Ground
18	Write Gate
19	Ground
20	Track 0
21	Ground
22	Write Protect
23	Ground
24	Read Data
25	Ground
26	Head Select

Acquisition Module (J14)

Pin No.	Signal
1	Power
2	Ground
3	TX+ (RS485)
4	TX- (RS485)
5	RX+ (RS485)
6	RX- (RS485)
7	NC
8	NC
9	NC
10	NC

General Fault Isolation

Visual Inspection

A thorough visual inspection of the equipment can save time. Small things—disconnected cables, foreign debris on circuit boards, missing hardware, loose components—can frequently cause symptoms and equipment failures that may appear to be unrelated and difficult to track.

Take the time to make all the recommended visual checks before starting any detailed troubleshooting procedures

Table 4-6. Visual Inspection List

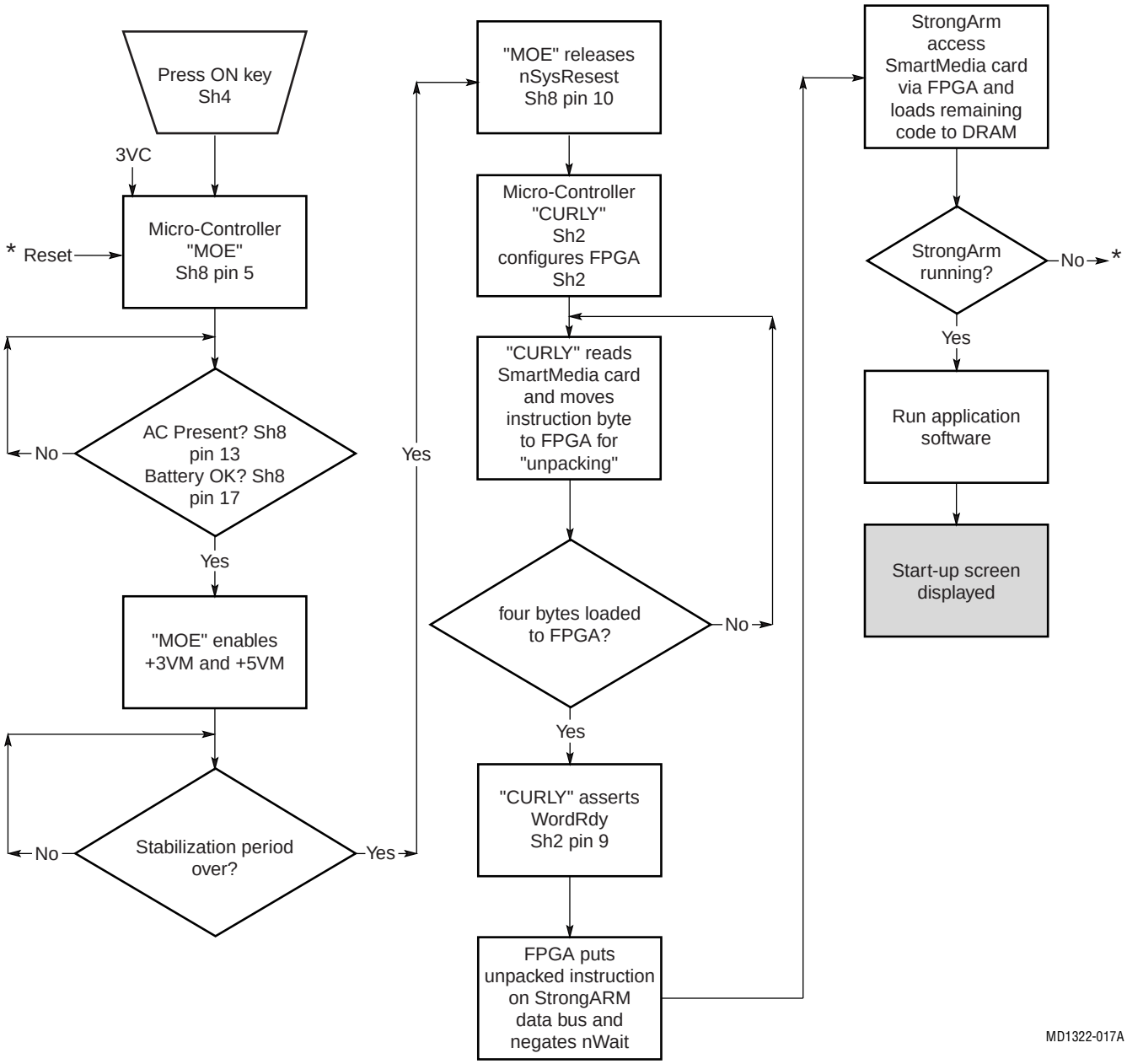
Area	Look for the following problems
I/O Connectors and Cables	■ Fraying or other damage ■ Bent prongs or pins ■ Cracked housing ■ Loose screws in plugs
Fuses	■ Type and rating. Replace as necessary.
Interface Cables	■ Excessive tension or wear ■ Loose connection ■ Strain reliefs out of place
Circuit Boards	■ Moisture, dust, or debris (top and bottom) ■ Loose or missing components ■ Burn damage or smell of over-heated components ■ Socketed components not firmly seated ■ PCB not seated properly in edge connectors ■ Solder problems: cracks, splashes on board, incomplete feedthrough, prior modifications or repairs
Ground Wires/Wiring	■ Loose wires or ground strap connections ■ Faulty wiring ■ Wires pinched or in vulnerable position
Mounting Hardware	■ Loose or missing screws or other hardware, especially fasteners used as connections to ground panes on PCBs
Power Source	■ Faulty wiring, especially AC outlet ■ Circuit not dedicated to system (Power source problems can cause static discharge, resetting problems, and noise.)

Power-up Self-test

On power-up, the system automatically runs an internal self-test. If all circuits test good, the start up screen displays.

Power-up Flow Chart

Refer to the CPU PCB schematic diagram found in the PCB Assemblies chapter at the end of the manual.



Poor Quality ECGs

Poor quality ECGs can be caused by factors in the environment, inadequate patient preparation, hardware failures related to the acquisition module, leadwires, cables, or problems in the unit.

Use a simulator to obtain an ECG report. If the report is good, the problem is external to the unit.

Diagnostic Tests

Introduction

Verify that the MAC 5000 resting ECG analysis system operates properly by running the diagnostic tests. These tests check the operation of the display screen, speaker, keyboard, thermal writer, battery, and communication. Detailed information displays on screen.

Loading the System Diagnostics

1. Select *Main Menu* on the Resting screen.
2. Select *More*.
3. Select *System Setup*.
4. At the prompt type the word “system”, the password set at the factory, then press the enter key. If the password was not changed, the *System Setup* menu appears. If the menu does not appear, use the master password. If the system’s unique password is inaccessible, create one following the instructions in “Substitute Master Password” later in this section.
5. When the *System Setup* menu displays, hold down shift and press **F5** (shift + **F5**).
6. Type “prod” at the service password prompt.
7. The *System Diagnostics* menu appears.

Substitute Master Password

If you do not have access to the system’s password, you can create a master password as follows.

1. At the prompt for the system password, enter **meimac**. A random 6-digit number displays on the screen. For example, 876743.
2. Write the number down and create a new 6-digit number by adding alternating digits from the random number as follows. Add:
   - first and third digits,
   - second and fourth digits,
   - third and fifth digits,
   - fourth and sixth digits,
   - fifth and first digits, and
   - sixth and second digits.

   Disregard the 10s column when adding the digits. The new number from the example above would be 440020.
3. Enter the new number, then press the enter key. The *System Setup* menu displays.

This process only works once, so you should reprogram the password permanently.

4. Go to the *Basic System* menu.
5. Select *Miscellaneous Setup*.
6. Select the *System password* line and type the new password in the space.
7. Press the enter key.
8. Select *Save Setup* from the *System Setup* menu.
9. Select *To system*.

System Diagnostics Main Menu

Use the arrow pad control to highlight a menu item, then press the enter key to select it. The tests and test menus contain on-line prompts and/or instructions.

- *Display Tests*
- *Speaker Test*
- *Keyboard Test*
- *Writer Tests*
- *Battery Tests*
- *Communication Tests*
- *Acq. Module Tests*
- *Analog I/O Tests*
- *Floppy Drive Tests*
- *Exit System Diagnostics* (reboots the system)

Display Tests

Run the screen display tests to verify that all the screen pixels are working and that the brightness and contrast samples appear to be within normal range. There are no screen display adjustments. The screen display tests are as follows.

Pixel Verification Test

Use the arrow pad control to move the bar across the screen and look for any missing pixels on the display.

Press the **F1** key to turn on all of the pixels simultaneously. Leave the screen in this test mode over night to remove the “burned-in” look to the softkeys.

Press the enter key to exit the test.

Grey Scale Test Patterns

The first test pattern (used in manufacturing to verify the screen intensity) shows two squares, one bright and one dim. Press any key to activate the next display.

The second test pattern shows 32 color levels. Check for problems with the overall pattern. (If the system does not have the color option, various grey scale patterns display.)

Press the enter key to exit the test.

Anti-Aliasing Test Pattern

This test pattern consists of a large square with a series of lines projecting from the center of the square to the perimeter of the square. Specifications not currently defined.

Press the enter key to exit the test. Highlight *Return* and press the enter key to return to the *System Diagnostics* menu.

Speaker Test

Use the arrow pad to select *Loud* or *Soft*. Press the enter key to produce a loud or soft tone. (The tone level difference is minimal.)

Highlight *Return* and press the enter key to return to the *System Diagnostics* menu.

Keyboard Test

Press each key and verify that the key is highlighted on the screen and also displayed at the top of the screen. (It is normal for a dim background image to remain on the screen when you select the next key.) The numeric value that displays at the top of the screen is the scan code representation of the pressed key.

NOTE

The display shows keys in the upper part of the screen that are not presently available on the keyboard.

- Check both of the shift keys by pressing each in combination with a letter to display a capital letter.
- Press the center of arrow pad control and verify that the word *IN* displays on screen. Press arrows to change the displayed arrow position. A beep sounds with each arrow press.
- Press the shift key and the **F6** key to exit the test.

Writer Tests

Run the writer tests to check the motor speed control, paper speed, paper tracking, paper cueing, and print head quality. During the tests, make the following general checks.

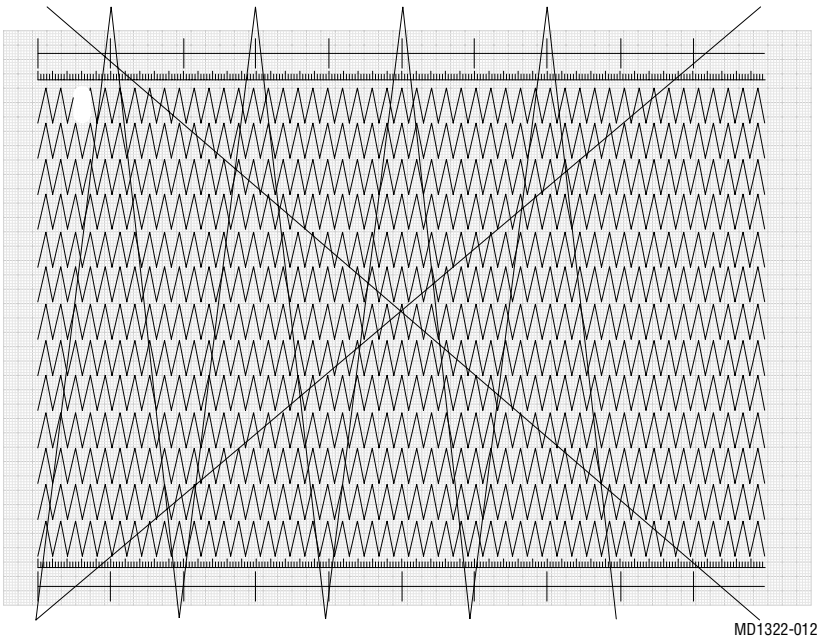
- The first character printed should not be distorted. This checks start-up speed.
- The writer should not skew or crush either edge of the paper.
- The large triangles and diagonal lines printed across the pages should be straight and uniform, without curves or wavering.
- The perfs should align with the tear bar on the door after cueing.
- Paper travel should be smooth.

C-Scan Test 1
C-Scan Test 2
C-Scan Test 3

These tests are combinations of test pattern I and the roller test. They are used by the vendor.

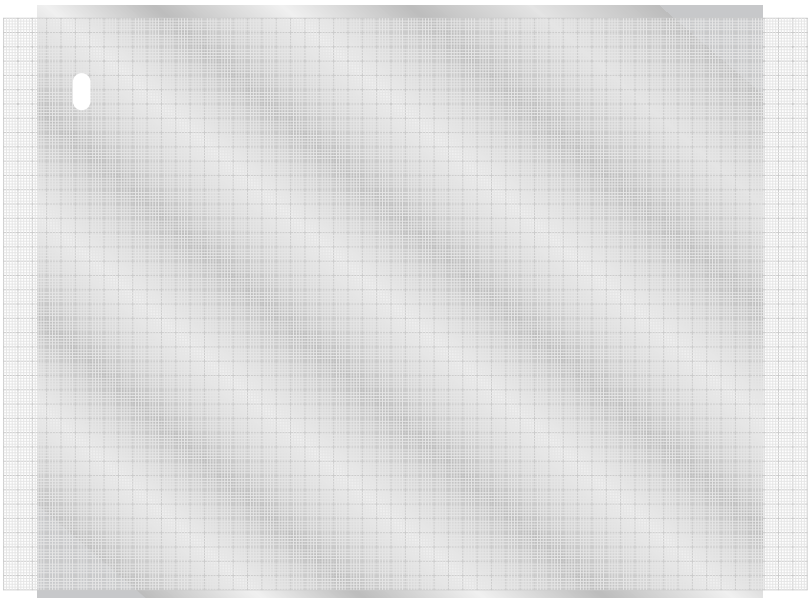
50 mm/s Test Pattern I
25 mm/s Test Pattern I
5 mm/s Test Pattern I

These test patterns check the motor speed control and the paper speed. Verify that the length of the printout from start to finish is 250 mm ± 5 mm. Use the grids located on the top and bottom of the page for reference. Do this for each of the three tests.



Roller Test (Uneven darkness can appear if AC power is on during this test.)

- After cueing, printing should start at approximately 13–14 mm on the page.
- The pattern appears as diagonal light and dark wavy bands.



MD1322-013

- Isolated light spots indicate a flat spot on the roller.
- A white line across the length of the page indicates a missing print head dot.
- Dark lines across the width of the page indicate gear tolerance problems.
- Lines too close together at the start of the test indicate an incorrect start-up speed.

Test Pattern II A combination of Test Pattern I and Roller tests. The first three pages consist of a series of triangular waveforms and various hashmarks. The fourth page is a partial roller test.

Test Pattern II Continuous Test Pattern II runs continuously until **stop** is pressed.

Continuously Run Out Paper This test is used in manufacturing to test how well the unit self-corrects tracking problems.

Battery Tests

Battery Status Displays, and constantly updates, the following information:

- Percent of charge remaining
- Battery voltage

- Battery current
- Battery temperature
- Maximum and minimum battery temperature
- Ambient temperature
- Maximum and minimum ambient temperature
- Current battery charging status

Battery Discharge Test

This test charges the battery to full capacity, if necessary, then monitors a discharge cycle. Monitored information, written to the floppy disk, includes:

- Discharge rate (in mAH)
- Battery temperature
- Battery charge status
- Percent of charge remaining

Battery Charge Test

This test completely discharges the battery, if necessary, then monitors a charge cycle. Monitored information, written to the floppy disk, includes:

- Charge rate (in mAH)
- Battery temperature
- Battery charge status
- Percent of charge

Print Discharge Test Results
Print Charge Test Results

Writes the results of the last discharge or charge test to a floppy disk for later printing to the writer.

Communication Tests

COM Port Loopback Test

The *Communications Port Loopback Test* sends various ASCII characters out the COM port's transmit lines and expects the same character to return in it's receive lines.

1. Select *COM 1: Base System* and press the enter key.
2. Follow the instructions on screen and install loopback jumpers in the COM 1 port. (Make note of these jumpers as they are the same for *COM 2 Modem Option* test.)

   While the test is in process, the word *Testing* appears in the upper right corner of the screen. Upon completion, the word *Passed* or *Failed* appears, depending on the results.
3. Remove the loopback jumpers when the test is complete.

Follow the same steps for the *COM 2 Modem Option* test.

Modem Test

Connect a modem to COM 2 and select the test. The test returns the modem ID number, firmware rev, and current parameter settings. If communication with the modem is unsuccessful, the ID and firmware rev display *N/A*.

Acq. Module Tests

Follow the instructions on screen.

- Tests if the front end is powered
- Tests if the front end is communicating
- Displays the front end noise floor
- Indicates when one of the three front end buttons is pressed

Analog I/O Tests

Analog Output Test

Follow the instructions on screen to monitor the analog outputs using an oscilloscope. The outputs monitored are:

- +12V
- DC Output 1
- DC Output 2
- ECG Output
- TTL Trigger Output

Four sets of outputs are possible. Select the output sets using the arrow pad.

Analog Input Test

Follow the instructions on screen to connect a DC voltage to the DC input pins of the ANA/TTL connector. The voltage of the DC input displays.

DCOut Loopback Test

Follow the instructions on screen to connect the DC Outputs to the DC Inputs. The test sends all possible values out the DC Outputs and confirms that the correct values are read from the DC Inputs. A pass/fail result displays.

ECGOut/QRSTrigger Loopback Test

Follow the instructions on screen to connect the ECG Output and TTL Trigger Output to the DC Inputs. The test sends all possible values out the ECG Output and a square wave out the TTL Trigger Output. It confirms that the correct values are read from the DC Inputs. A pass/fail result displays.

Floppy Drive Tests

Follow the instructions on screen. A read/write test is performed on a formatted floppy disk. A pass/fail test result displays.

A head radial alignment and Azimuth alignment test is performed using an Accurite test disk. Test values display.

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General Description

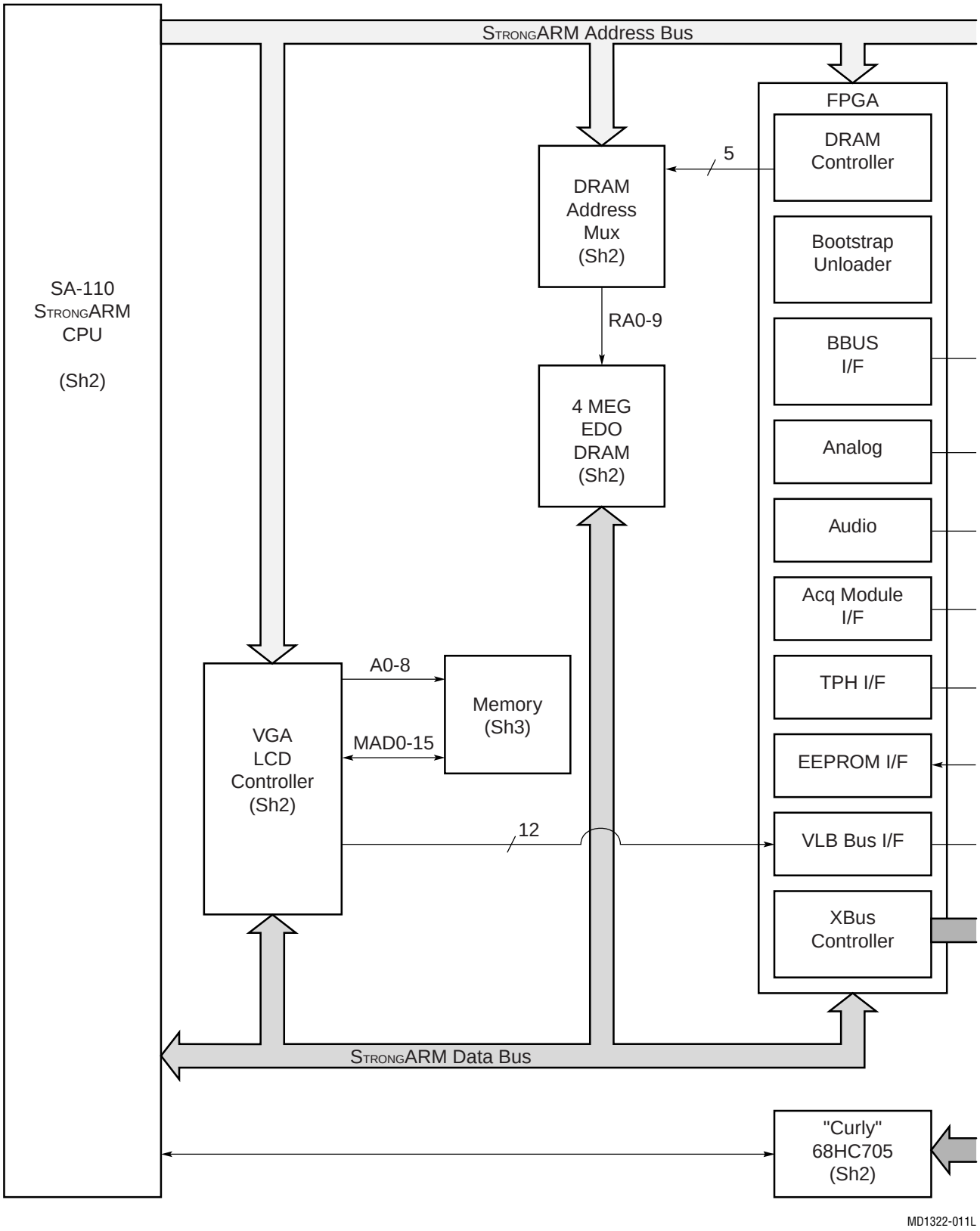
The MAC 5000 CPU PCB contains all of the circuitry for the MAC 5000 resting ECG analysis system except for the power supply, acquisition module, keyboard and display.

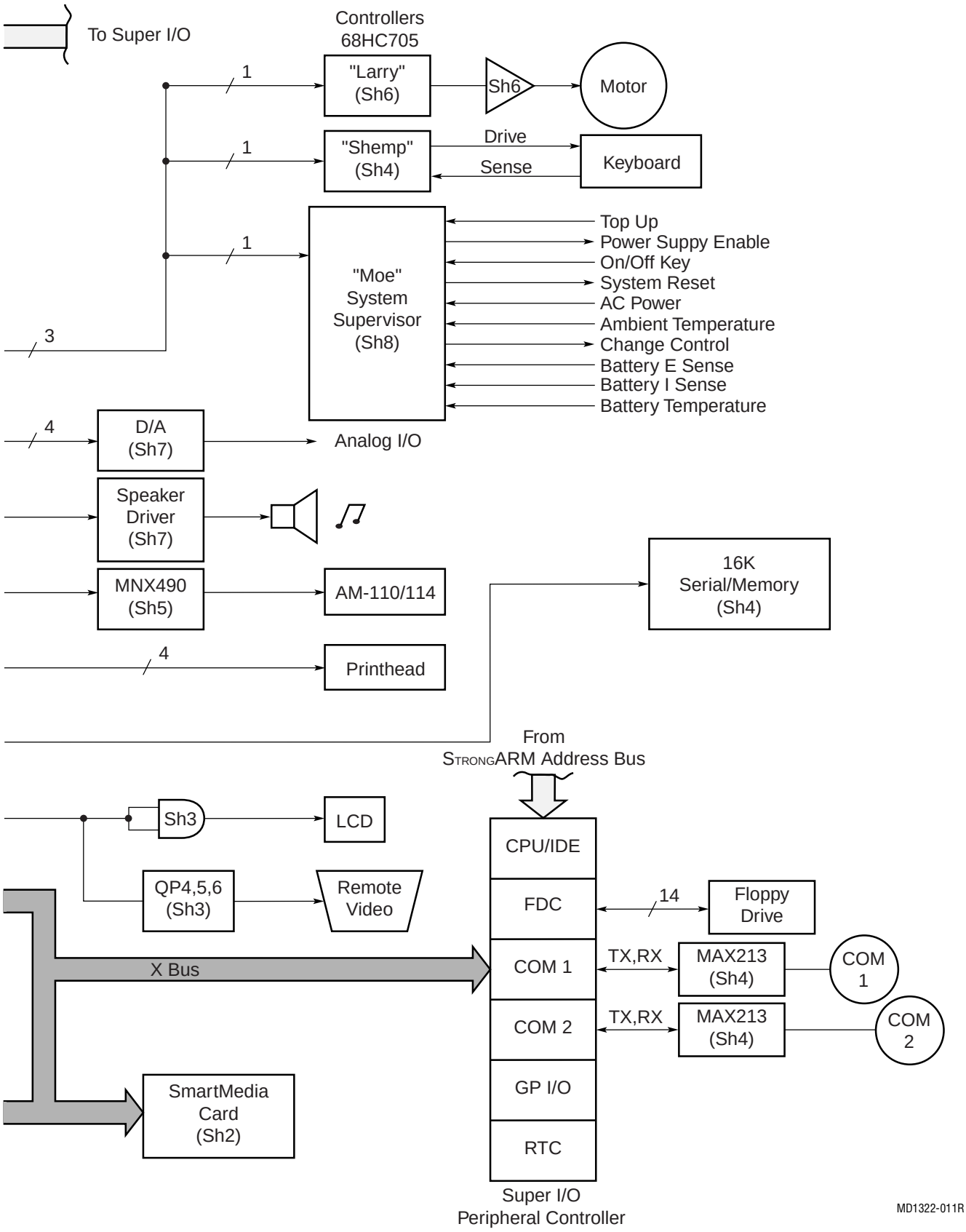
The board contains the following:

- Clocks
- StrongARM CPU (SA-110)
- FPGA for System Logic Containing:
  Bootstrap Instruction Unpacker
  EDO DRAM Controller
  XBus Controller
  LCD Controller VLB Bus Interface
  Video Waveform Scroller
  Interrupt Controller
  System Interrupt Generator
  Acquisition Module Interface
  Thermal Printhead Interface
  Serial EEPROM Interface
  BBus Interface
  Two UARTs
  Four PWM Analog Outputs
  Beep Generator
  Two Serial Ports
- 4MBytes EDO DRAM (holds both code and data)
- 2MBytes SmartMedia Flash (holds FPGA configuration and system code)
- VGA LCD Controller and CRT video DACs
- Acquisition Module Transceiver/Power Switch
- Thermal Printhead Power Switch and Pixel Test Circuit
- A PC SuperIO controller containing:
  Floppy Disc Drive Controller
  Two Serial Ports (one dual mode RS-232 / IrDA)
  Clock/Calendar (Y2K compliant even!)
  PS-2 Keyboard Port (for card and bar-code readers)
  General Purpose Parallel I/O Port for Miscellaneous Control
- Four Stooges Controlled Resources:
  Four Stooges Overview
  Bootstrap Control (Curly)
  Keyboard Interface (Shemp)
  Printer Motor Controller/Analog Input (Larry)
  Main Power Supplies/Battery Charger-Gauge (Moe)

Block Diagram

See Chapter 7, "PCB Assemblies" for references on the CPU schematic.




To Super I/O
Controllers
68HC705
1
"Larry"
(Sh6)
Sh6
Motor
1
"Shemp"
(Sh4)
Drive
Sense
Keyboard
1
"Moe"
System
Supervisor
(Sh8)
Top Up
Power Suppy Enable
On/Off Key
System Reset
AC Power
Ambient Temperature
Change Control
Battery E Sense
Battery I Sense
Battery Temperature
3
4
D/A
(Sh7)
Analog I/O
Speaker
Driver
(Sh7)
MNX490
(Sh5)
AM-110/114
16K
Serial/Memory
(Sh4)
4
Printhead
From
StrongARM Address Bus
Sh3
LCD
CPU/IDE
QP4,5,6
(Sh3)
Remote
Video
FDC
14
Floppy
Drive
X Bus
COM 1
TX,RX
MAX213
(Sh4)
COM
1
COM 2
TX,RX
MAX213
(Sh4)
COM
2
GP I/O
SmartMedia
Card
(Sh2)
RTC
Super I/O
Peripheral Controller
MD1322-011R

Theory of Operation

Clocks

The main system logic operates from one of three clocks, all derived from a single 24MHz oscillator. That 24MHz clock is used directly by the FPGA to control the timing of internal peripherals. It is also used as the reference frequency for the LCD controller PLL clock synthesizer (after division to 12MHz) and the PLL clock synthesizer in the StrongARM (after division to 4MHz). In addition, each of the four HC05 microcontrollers has its own 4MHz ceramic resonator.

CPU

The Intel StrongARM SA-110 CPU, chosen for its high performance, low power consumption and high code density, is at the heart of MAC 5000. The SA-110 is a bare processor with no integrated peripherals other than clock generation, MMU and L1 cache. The StrongARM core and bus clocks are generated internally from an external reference clock. The multiplying factors for each clock are set by strapping configuration pins. See theCPU schematic and StrongARM data sheet for the current CPU and bus speed settings (at the time of this writing, the CPU clock was 206MHz and the bus clock was 26MHz).

FPGA

All of the MAC 5000's proprietary hardware is contained in a single Xilinx FPGA which contains:

- Bootstrap Instruction Unpacker
- EDO DRAM Controller
- XBus Controller
- LCD Controller VLB Bus Interface
- Video Waveform Scroller
- Interrupt Controller
- System Interrupt Generator
- Acquisition Module Interface
- Thermal Printhead Interface
- Serial EEPROM Interface
- BBus Interface
- Two UARTs
- Four PWMAnalog Outputs
- Beep Generator
- Two Serial Ports

The following descriptions give an overview of the FPGA's functionality. For detailed information on the internal circuitry, refer to the schematic.

Bootstrap Instruction Unpacker

The FPGA provides an interface that unpacks instructions to start the CPU from the byte wide SmartMedia card. Early during system startup, Curly extracts instruction bytes from the card and presents them to the FPGA for unpacking. Each instruction byte is loaded into the FPGA via the signal ByteRdy. Curly asserts the SmartMedia nFRD signal while simultaneously asserting ByteRdy to improve transfer rate. Curly generally does not examine the instruction bytes (a more complete explanation of the bootstrap process is presented in Curly's source code). When four bytes (one instruction) have been loaded into the FPGA, Curly asserts WordRdy and the FPGA places the unpacked instruction on the StrongARM data bus and negates nWait, allowing the StrongARM to fetch and execute the instruction. In this fashion the initial bootstrap loader is loaded into main DRAM. Curly's read rate is far too low to load all code from the card, so only a simple bootstrap program is copied to DRAM. This program contains code that allows the StrongARM to access the SmartMedia card directly through the FPGA. Once that initial bootstrap is loaded, Curly disconnects from the circuit (tri states all pins except nReset) and stops its internal clock. StrongARM execution is transferred to the bootstrap loader in DRAM and the remaining system code is read from the card at high speed. The byte unpacker lies dormant until the next startup.

EDO DRAM Controller

MAC 5000 main memory is comprised of 4MBytes (2 1M x 16 devices) of EDO DRAM. The FPGA provides a burst interface to DRAM that allows 8 word bursts at 4-1-1-1-1-1-1-1 clocks. Write bursts run at 4-2-2-2-2-2-2-2 clocks. Single read/write accesses take 5 clocks. Refresh cycles (5 clocks) are queued approximately every 10 microseconds for an overhead of 2 percent. The control of DRAM nCAS requires logic delays shorter than can be obtained in the FPGA. For this reason a 3.5ns PAL provides the final stage of nCAS control. Enabling signals are provided by the FPGA and the PAL anchors the final nCAS signals off the main bus clock (nMCLK).

XBus Controller

To reduce loading on the high speed processor address and data busses, a slow speed byte bus is provided for peripheral interface. The SuperIO controller and SmartMedia card are both located on this bus. XBus is decoupled from main bus traffic to reduce EMI. XBus data lines are only active when an XBus device is being accessed. Unlike the 3.3V only main data/address busses, XBus is compatible with both 5V and 3.3V logic. StrongARM address lines A8..11 are buffered by the FPGA for use by XBus devices. To reduce loading on A1..A3 which drive the DRAM burst addresses, the low order address byte is not used by XBus. Starting XBus addressing with A8 also produces SuperIO addresses which easily map to their standard PC equivalents (simply append 00 to a PC SuperIO address to get a MAC5000 SuperIO address).

LCD Controller VLB Bus Cycle Interface

The LCD controller expects VESA local bus signaling, not StrongARM bus signaling. The FPGA provides the necessary logic to interface the StrongARM nMReq/nWait interface to the LCD controller's nCS/nRdy/nRdyRtn interface. The LCD controller does not support burst accesses .

Note: No LCD controller bus timeout logic is provided, so accesses to unmapped regions of controller space will hang the system.

Video Waveform Scrolling

There are numerous ways of achieving this effect, none of which is supported by standard LCD controllers. MAC 5000 achieves scrolling through FPGA hardware placed between the LCD controller output and the LCD panel input.

To achieve the scrolling effect it is necessary to maintain two virtual image planes, one atop the other. Static (stationary) objects are drawn in the static plane, which appears nearest the viewer and may be either opaque or transparent. Dynamic (scrolling) objects are drawn in the dynamic plane, which appears behind the static plane and is always opaque, though not necessarily visible. The appearance of motion is achieved by constantly changing the start point for display of the dynamic plane from one display frame to the next.

Since the LCD controller does not support multiple image planes, it is necessary to pack two planes of image data into a single frame buffer. On the software side (during drawing) this is done by bit masking operations that allow separate manipulation of two virtual pixels in each byte of frame buffer memory. Each 8-bit byte holds a pair of pixels, one from the static plane and one from the dynamic plane.

On the hardware side, part of each frame buffer byte (the static plane) is played directly into the LCD after suitable color mapping. The remainder of the frame buffer byte (the dynamic plane) is stored in a 1 line temporal buffer before being displayed. The amount of delay applied to the line buffer before merging it with the static image data determines it's placement on the screen. By gradually changing the delay, the dynamic image can be made to scroll.

In MAC 5000, each byte of frame buffer data is divided into a 5-bit field for the static plane and a 3-bit field for the dynamic plane. This provides a palette of 2^3=8 colors for dynamic objects and (2^5)-1=31 colors for static objects (1 of the colors is transparent, leaving 31 real colors). In practice, to be able to "freeze" dynamic objects requires that the 8 dynamic colors be replicated in the static color map, so there are actually only 31-8=23 new colors available for static objects. The FPGA implements a writeable color lookup table (CLUT) to map the pixel values to sensible colors on the LCD. The CLUT provides 32 24-bit entries, providing access to the complete color space offered by the LCD panel.

LCD data is also fed to three external discrete 6-bit DACs to create video for an external CRT. The horizontal and vertical sync pulses from the LCD controller are combined to produce a composite sync signal which is added to the green video. The FPGA's asymmetric output drive current (stronger pulldown than pullup) makes it difficult to source video DAC currents directly into a 75Ω video cable. To allow the FPGA to sink rather than source the video DAC currents, the video output is referenced to the 3.3V supply rail and then level shifted back down to ground by emitter followers. The DC level is restored by a second set of emitter follower clamps referenced to two diode drops above ground. By using dual transistor packs of the same type, temperature and process drift are minimized.

Interrupt Controller

The StrongARM supports two external interrupts, FIQ (Fast Interrupt Request) and IRQ (Interrupt ReQuest). The FPGA expands these inputs to service numerous sources of interrupts in the FPGA internal logic and SuperIO. Each interrupt source is routed to either the FIQ or IRQ pin and is provided with a writeable enable bit and a readable status bit. Note in particular that the FIQ status bits are masked by FIQ mask bits whereas IRQ status bits are not. This reflects the different needs of the FIQ and IRQ interrupt handlers.

System Interrupt Generator

A 1KHz timer generates system interrupts (which may be routed to FIQ or IRQ) once every millisecond. This interrupt provides the foundation for all operating system timers.

Acquisition Module Interface

Acquisition module timing is synchronized to the system clock. Data is framed and checksummed. Commands may be sent without interrupting the data stream. The acquisition module supports three buttons whose state is communicated to the system in each ECG data packet.

A constant reference clock frequency of 1MHz must be provided to the acquisition module for generation of it's internal sampling clocks. To eliminate the need for extra wires, command information is encoded on this reference clock by altering its duty cycle. The FPGA provides a serializer for the command bytes and clock generator/modulator to transmit both the clock and command bits from the serializer. The reference clock duty cycle is nominally 50%. By altering the duty cycle, the DC content of the clock may be changed. This change in DC level is detected by the acquisition module. The timing of these shifts in DC offset encode command data bits. A zero is encoded as a single shift in duty cycle from 50% to 25% lasting 30µs, followed by a refractory period of 220µs. A one is encoded as a pair of 30µs periods of 25% duty cycle separated by 90µs, followed by a 90µs refractory period. In either case the transmission of a single bit takes 250µs. Only the falling edge of the clock signal is moved to alter the duty cycle. This leaves a pristine rising edge for the acquisition module to use as the reference for its PLL clock generator. A higher level protocol organizes commands as groups of 8 bits.

Data from the acquisition module is packed into 257 bit NRZ frames. The idle state of the receive line is high. The first bit of each packet is a zero and serves as the packet start bit. As with a UART, the start bit is discarded. The following 256 bits are received into a 16 word x 16 bit buffer for use by the StrongARM. The receive logic then looks for an idle period (analogous to a UART stop bit) of at least 128µs in length as an indicator that the link is again idle. Special marker words are inserted into the ECG data packet (words 5, 9 and 13) to guarantee there will never be a run of more than 80 bits of one's (or zeros), so there is no possibility of satisfying the idle period requirement in the middle of a data packet. Because the acquisition module clock is supplied by the FPGA, receive bit timing errors are limited to phase uncertainty. By searching for the beginning of the start bit in a fashion similar to that used by UARTs the phase uncertainty is eliminated and the remainder of the packet may be received without further synchronization. In practice, the FPGA uses every edge in the receive data stream to re-sync

its bit sampling circuit. It is possible for the ECG data to be all zeros or ones, so runs of as many as 80 zeros or ones could occur before a marker word is encountered in the data stream (which contains at least one "1" and one "0" to break any runs in the data).

The acquisition module supports a special "code update" mode for rapid reprogramming of it's on-board code memory. To increase the update speed, the acquisition module echoes each uploaded code byte with a single reply word rather than the usual 16 word data packet. The FPGA receive logic provides a special 1 word reception mode to accommodate this.

Thermal Printhead Interface

The StrongARM sends print data to the thermal print head through a buffered serial interface. The FPGA implements the data buffer, serializer, strobe/latch pulse generator and power switch gate drive pump. Special interlocks are implemented to prevent stuck strobe signals or printing when the battery voltage is critically low.

Each print line requires 1728 bits of data. To conserve FPGA resources, each line is divided into three chunks of 512 bits each, with one leftover chunk of 192 bits. The FPGA provides a single 16 word x 32 bit buffer (512 bits) to hold the print line data. After writing a chunk of data to the buffer, the StrongARM enables serialization of the data by reading one of two registers (to support the serialization of either a full 512 bit or partial 192 bit buffer). When the entire print line has been loaded, the StrongARM cues a print strobe by writing the required strobe width value to the strobe/latch pulse generator.

When the strobe register contains a non-zero value, the power switch gate pump produces a differential clock signal to drive an external diode voltage doubler. The output of the voltage doubler drives the gate of a power MOSFET which provides power to the print head.

A special test mode is provided to allow testing of the thermal print head. In test mode, print head power is disabled and the strobe signal is driven continuously. This allows individual print dots to be driven with a small test current. The resulting voltage drop may be measured to either determine the dot's resistance or a least determine of the dot is open.

Serial EEPROM Interface

A standard SPI interface is provided for connection to a serial EEPROM memory. The StrongARM exchanges a byte of data with the EEPROM by writing a value to the interface register. Data is clocked at 4MHz, quickly enough that no interrupt support is required. The StrongARM polls a ready bit to determine when the transfer is complete.

BBus Interface

There are several I/O functions poorly suited to direct control by the StrongARM, whether for reasons of software complexity or power consumption. These I/O functions are provided by three 68HC705 microcontrollers placed strategically around the board (Moe, Larry and Shemp). Each of these three microcontrollers must communicate with the StrongARM. BBus is a simple 1-wire point-to-point interface designed specifically for this purpose. The FPGA provides a single BBus

transceiver and a 3-way bi-directional multiplexer to attach to the three BBus microcontrollers. From the programmer's standpoint, BBus operates like SPI, where each transaction exchanges a single byte between the host and peripheral.

UARTS

Two full duplex UARTs are provided for COM3 and COM4. Each has programmable bit rates, but no handshake lines are provided. The receiver is double buffered, the transmitter single buffered. To reduce cost and conserve panel space, the COM3 and COM4 signal lines are connected to the COM1 handshake lines, so COM1 handshake functionality must be sacrificed to use COM3 or COM4. The COM3 and COM4 TxD outputs may be tri-stated to allow the COM1 handshake output lines to operate normally.

The handshake lines are shared as follows:

- COM3 TxD COM1 RTS
- COM3 RxD COM1 CTS
- COM4 TxD COM1 DTR
- COM4 RxD COM1 DSR

The available bit rates are: 1200, 4800, 9600, 19.2K, 38.4K and 115.2Kbps. The only frame format supported is 8N1.

Interrupts for COM3,4 are shared on a single IRQ vector. Tx buffer ready, Tx buffer clear and Rx buffer full status bits are provided.

Note that when COM2 is in IrDA mode the COM2 handshake lines are not used and COM3 and COM4 may be used without loss of COM2 functionality.

PWM Analog Outputs

Four PWM channels are provided for the generation of analog outputs. Three of the outputs are available on the Analog I/O connector, the fourth is available internally for future use. One of the PWM channels provides 12-bit resolution at 6KHz cycle rate, the other three provide 8-bit resolution at 96KHz cycle rate. The StrongARM simply writes the desired value into a PWM data register and the output duty cycle changes on the next PWM cycle. External analog circuitry converts the PWM logic signals to smooth analog voltages. The 12-bit PWM channel is intended for ECG output and produces a swing of +10 to -10V. The two 8-bit channels provide a unipolar 10V output. Regardless of the resolution or swing range of each PWM channel, the FPGA treats the data value as a signed 16-bit number representing a voltage from +10V (0x7fff) to -10V(0x8000). Logic in each PWM channel ensures that the closest possible voltage is generated for each data value (ex. 0x8000 on an 8-bit channel produces zero volts output).

Beep Generator

A simple tone generator with two volume levels provides the system beep tones. Frequencies of 250Hz, 500Hz and 1KHz are provided at both low and high volume. The logic level output signal drives a speaker through an open collector transistor driver.

DRAM

Program code and working data is stored in a single 1MWord bank of 32-bit wide memory (4MBytes). EDO DRAM is used to achieve moderate burst rates (75MBytes/sec @ 26MHz bus speed). All bus timing and refresh control is performed by the FPGA.

SmartMedia Card

FPGA configuration data and system software are stored on a SmartMedia card. The system can accommodate sizes from 2MBytes to 16MBytes. To reduce loading on the processor address/data busses, the SmartMedia card is accessed by the StrongARM via the isolated XBus. Special gating is provided for the SmartMedia CS pin to reduce susceptibility to accidental writes.

Serial EEPROM

System setup information, option enables and other machine specific data is stored in a 16KByte serial EEPROM. The interface to the EEPROM is provided by the FPGA.

VGA LCD/CRT Interface

Control for a standard VGA format (640 x 480 pixels) LC display is provided by the FPGA. A connector is provided for an external CCFL backlight inverter as well as two digital controls for On/Off and brightness.

Acquisition Module Transceiver/Power Switch

MAC 5000 acquires ECG data with a new generation CAM-14 acquisition module. The FPGA provides the interface logic. Clocks and commands are transmitted to the acquisition module on a balanced RS485 line. Data is received similarly. Both directions are handled by a single RS485 transceiver. Power to the acquisition module is provided by a software controlled switch/current limiter.

Normal system operation is sufficient to verify the correct operation of the acquisition module interface. The module power switch/current limiter may be tested against spec as indicated elsewhere in this document.

Thermal Printhead Power/Pixel Test Logic

The FPGA provides all the interface logic for the thermal print head. Power is controlled by a MOSFET switch whose gate drive is provided by a charge pump voltage doubler driven by the FPGA.

Additional circuitry is supplied to allow the measurement of individual dot resistance for automatic strobe width compensation and blown dot detection. A switchable constant current source (6mA) applies a test current to the TPH power bus. The TPH power bus voltage is then measured by Larry (one of the four analog inputs he continuously monitors). By loading a single black dot into the print head, it is possible to measure its resistance. A typical TPH has an average dot resistance of

650 ohms. Presuming negligible driver leakage current, a single enabled dot would drop 3.9V. While there are mitigating influences (off-pixel driver leakage current and on-pixel driver saturation voltage) that might make accurate pixel resistance measurements difficult, it is certainly possible to differentiate pixels of nominal resistance from those that are blown open.

SuperIO Peripheral Controller

A PC standard SuperIO peripheral controller provides floppy drive support, two serial channels (one IrDA compatible) a clock/calendar and some miscellaneous parallel port I/O.

Floppy Drive Support

The SuperIO provides support for a 3.5” 1.44MByte IBM format floppy diskette drive. The FPGA provides DMA like interrupt support for the floppy controller. A special chip select supplies the DMA acknowledge signal that gates data to/from the SuperIO floppy controller via the XBus. To ensure no data is lost, the floppy DMA request is routed to the StrongARM’s FIQ input.

Four RS-232 Serial Ports (one dual mode RS-232/IrDA)

Four serial ports are provided on two back panel Mini-DIN 8 pin connectors. Two serial ports (COM1 and COM2) are provided by the SuperIO device and two (COM3 and COM4) are provided by the FPGA. The SuperIO UARTs are full featured 16550 equivalents while the FPGA ports are minimal implementations with a limited set of bit rates, a single 8N1 format and no handshake lines. COM3 and COM4 are remultiplexed onto the COM1 handshake lines (see FPGA section more COM3/4 details).

Clock/Calendar

The SuperIO device provides a clock/calendar function. Backup battery power is provided by a "super" capacitor with sufficient storage capacity to power the clock for hours. This backup source provides more than sufficient time to exchange battery packs when necessary.

External PS-2 Keyboard Port

External card/bar code readers may be connected to the MAC5000 via a PS-2 compatible keyboard port. A small amount of 5V power is available at the connector to power the external device. Power faults are detectable.

General Purpose Parallel I/O Lines

The SuperIO device provides 16 general purpose parallel I/O lines. These are used for various control and sensing purposes about the design.

The Four Stooges

System management and some low level I/O functions are implemented in preprogrammed 68HC05 microcontrollers. Moving some I/O functions out into small processors relieves the StrongARM of burdensome real-time chores and moves the control hardware closer to the controlled devices, potentially reducing EMI. Localizing control also promotes reuse in future designs as the functions are self contained and reasonably portable.

Although there are four of these little fellows in the MAC 5000, each performing a different function, there is only one firmware image. By merging the code from each of the four functions into a single ROM image confusion is reduced. It is impossible to place a processor in the wrong spot on the board.

Startup Self Identification

As each controller is released from reset, it executes a common "WhoAmI" routine to determine its identity on the board. Each controller's environment is uniquely and easily identified with a few port pin tests. Once the identity is discovered, the code jumps to the appropriate entry point in the unified image and microcontroller assumes the desired personality.

BBus

Three of the four stooges (Moe, Larry and Shemp) communicate with the StrongARM via BBus connections. BBus is a single wire, half-duplex serial connection that places minimal hardware requirements on the microcontroller while yielding respectable bit transfer rates (~50KBps). A common set of BBus commands allow the StrongARM to access 128 bytes of RAM in each microcontroller. This dual port access allows the StrongARM to examine and modify internal variables in each controller while code is executing. This ability is used to allow the unalterable HC05 code to handle modest changes in hardware, such as changes in paper drive gearing or battery pack capacity.

Curly

Curly is responsible for configuring the FPGA and loading the first level bootstrap program into the StrongARM. When Reset is released, Curly reads the PCB ID code from three port pins and then searches the SmartMedia card via the XBus data bus for a matching FPGA configuration image (pages with ID "Xn" where n is the 3-bit PCB ID code 1-8). Once located, the configuration image is loaded into the FPGA. Included in the FPGA internal logic is "bus-unpacking" circuitry that constructs 32-bit wide StrongARM instructions from sequences of bytes on the X data bus. During the earliest phase of the startup process, these bytes are read from the SmartMedia card by Curly and then loaded into the "bus-unpacker". This early bootstrap code is stored in the SmartMedia card in a special format that Curly understands and contains a small program that enables the StrongARM to read the SmartMedia card by itself. Once this first stage bootstrap program is loaded (SmartMedia ID of "Bn", where n is the PCB ID) the StrongARM is able to read the SmartMedia card without Curly's help and Curly shuts off (effectively disappearing from the circuit) until the next system startup.

Shemp

Shemp scans the keyboard and queues key presses for the StrongARM. Key presses are reported both on press and release, allowing system software to implement auto-repeat as well as the continuous operation of treadmill control keys (up/down, faster/slower). A special key code indicates when all keys are up as a safeguard against stuck keys in the application software.

Larry

Larry controls the paper drive motor and quantizes the analog inputs. Since Larry's code is not field alterable, every motor control parameter is alterable via BBus. Hopefully this renders the code immune to minor changes in the printer drive train.

Larry controls the motor speed by delivering a DAC controlled drive voltage to the motor windings. The 6-bit DAC is implemented using discrete, binary-weighted resistors directly driven by Larry's port pins. The DAC output voltage is compared to a filtered fraction of the applied DC motor voltage by a comparator. If the motor feedback voltage is below the DAC voltage, the comparator turns on the motor via an H-Bridge driver. One motor terminal (which one is a function of motor direction) is always grounded. The other is alternately driven to either 12V or ground. The duty cycle of the drive signal determines the average applied voltage and therefore the average motor speed. The feedback voltage signal is the average of both motor terminals. Since one terminal is always grounded and the other is driven with a variable duty cycle between zero and 12V, the feedback signal is positive regardless of motor direction. An RC filter provides a DC feedback voltage from the chopped motor drive.

Cue and out-of-paper conditions are sensed via the thermal print head's integral optical cue sensor.

Four analog inputs are digitized by Larry:

- TPH Temperature
- TPH Dot Resistance
- External Analog Input #1
- External Analog Input #2

The sampling rate is indeterminate, but guaranteed to be at least 100Hz. The external analog inputs are intended to be DC signals from devices such as ergo bikes or NIBP meters, so no effort is made to synchronize sampling with the ECG signal. All input signals are low-pass filtered to avoid aliasing EMI. The external analog input range is 0-10V. Zero volts produces a code of zero, 10V produces a code of 0xff. The TPH dot resistance input has a nominal sensitivity of 3.32 Ohms/count. A nominal print dot (650 Ohms) would produce a reading of 196.

Moe

Moe is responsible for controlling and monitoring the battery, power supplies, on/off key, system reset and related functions. Moe runs continuously (on +3V-C), even in the absence of AC power. This continuous operation is necessary for Moe to accurately monitor the battery state of charge.

System Startup

When the system is off and the user presses the power key, Moe begins the startup sequence. If the battery contains sufficient charge, or if AC power is applied, the mainCPU power supplies (+3V-M and +5V-M) are enabled and after a suitable stabilization period nSysReset is released. Moe then keeps tabs on the system via a software watchdog that must

be serviced by specific BBus activity from the StrongARM. Moe himself is monitored by a self contained MAX823 watchdog timer / brownout detector. Moe must constantly toggle the MAX823 watchdog input pin or suffer the consequences.

Note: Moe presumes that the main power rails are off when he powers up. If +3V-M is up when Moe restarts the self ID code will incorrectly assume that Moe is actually Larry. As +3V-M is controlled by Moe, this should never happen. Even if Moe halts while operating, the minimum MAX823 reset period of 100ms virtually guarantees that +3V-M will be down before Moe comes out of reset (HC05 port pins tri-state in reset and the main power enable input to the MAX782 switching regulator is pulled down by a resistor).

When nSysReset is released, Curly configures the FPGA and starts the StrongARM from information stored in the SmartMedia card. Moe expects the StrongARM to request status via the BBus interface within a few seconds of startup. If that request doesn't arrive in time, Moe places the system back in reset and removes power.

AC Power/Battery/Charger

Battery and system power management is entirely Moe's responsibility.

An off-the-shelf 28V 1A universal input power supply provides operating/charging power for the MAC 5000. Located in the bottom of the chassis, the power supply is disconnected from theCPU when the lid is open. The battery connection is maintained through the hinge, so the CPU is capable of operating for a limited time with the door open.

A self-aligning connector routes power and motor signals from the power supply compartment to the CPU. When the lid is closed the DoorOpen signal is shorted to ground. When the lid is open a pullup resistor ensures a high level on DoorOpen. Moe monitors this line to detect lid open conditions which are reported to the system software to avoid misinterpretation of motor fault indications. When the door is open, the motor connections are lost and Larry receives no tachometer feedback from the motor. Without knowing the cause of the lost tach info, Larry can only respond with a paper jam condition. Moe's knowledge of the lid state is used to suppress this error message as well as prevent further print operations.

AC Power Monitor

Moe senses the presence of AC power. The battery charger will not be enabled unless AC power is detected.

Ambient Thermistor

Extreme hot/cold ambient conditions are not favorable for battery charging. Rapid changes in ambient temperature can cause premature or delayed charge termination by altering the packs temperature. Moe monitors ambient temperature to ensure that charging occurs only within the "safe" temperature range as well as to minimize the effects of changing ambient temperature on charge termination (particularly to

avoid premature termination, which would give a false "full" reading on the gas gauge).

Battery Pack

The MAC 5000 uses a 15-cell nickel metal hydride (NiMH) battery pack with integral thermal sensor for charge termination detection and self resetting fuse for short circuit protection. Charge current and normal system operating power are obtained from the AC power supply. The charger circuitry monitors both battery charge current and power supply output current. The battery is always charged at the maximum rate possible but system power demands take precedence over charger demands. The charger automatically reduces charge current as required to keep the AC power supply output current within specified limits. In the extreme (during printing) charging ceases and energy is taken from the battery to meet peak system demands. When system power draw declines, all excess power supply capacity is once again delivered to the battery.

Battery Thermistor

The thermal sensor is used by Moe for termination of charge. During normal charge, the electrical energy obtained from the power supply is stored in chemical reactions in the battery. When the battery reaches full charge there are no more reactants available in which to store chemical energy and the supplied charge power is converted directly to heat. The sudden rise in pack temperature caused by this release of heat is an indicator of full charge. When the rate of pack temperature rise exceeds a certain threshold, charge is terminated. This is the only normal charge termination mechanism, though abnormal conditions (battery or ambient temperatures beyond spec or excessive pack voltage) may also terminate charge. Once fully charged, the battery is maintained by low duty cycle charge current pulses.

Charge Light

Moe provides power to the amber charge light in the power supply compartment. Moe communicates the current battery/charger state via this light.

Four conditions may be indicated:

- Battery charged (light is off)
- Battery needs charge (light blinks once per second)
- Battery is critically low (light flashes furiously)
- Battery is charging (light on continuously)

Battery Gauge

Current flow into and out of the battery pack is monitored by Moe via a MAX472 current sensor (IMON). By integrating the current flow, Moe is able to maintain a reasonable estimate of the battery pack's charge. The current sensor hasn't sufficient dynamic range to cover the full scale of system current draw so some compromises are made. The very highest

peak currents (drawn during printing) are clipped to the current monitor's full scale value. The effects of this are minimal as such high density printing occurs for short periods of time and represents only a small portion of system energy consumption. Quantization error limits the ability to measure the small current that flows when the system is off. To compensate for this, Moe presumes a small constant quiescent current flow from the battery. This flow serves to drain the gauge at a rate estimated to mimic the self discharge and system quiescent current draws.

Operation with Discharged Batteries

On AC power, the MAC 5000 can operate indefinitely with a discharged battery, though it may not be able to print until sufficient charge has been placed in the pack to support peak current demands. Normally, only a minute or two of charge is sufficient to get through the printing of a single page report.

Main Power Supplies

The MAC 5000 contains a mix of 3.3 and 5V logic. Both supply rails are provided by a high efficiency synchronous buck regulator device (Maxim MAX782). This device is the "Swiss army knife" of switching regulators, providing the main logic rails as well as 3V-C, which powers Moe. A medium current (1A) semi regulated 13V output is also provided to feed a pair of low current linear regulators as well as provide power for other loads. One of the low current linear regulators is used to provide 12V for the analog output hardware. The semi-regulated rail is also used to power the acquisition module.

Acquisition Module Power Switch/Regulator/Current Limiter

A discrete MOSFET based linear regulator applies crude regulation to the MAX782 semi-regulated rail for use by the acquisition module. The regulator may be turned on/off under software control and contains a built in current limiter/sensor to protect against short circuits.

Main 12V Rail

An integrated switching regulator provides 12VDC for the LCD backlight, motor and external peripheral devices. Input power to the regulator is controlled by a MOSFET power switch under software control.

External 12V Rail Switch/Current Limiter

12V power for external peripherals (modem or suction electrode pump) is switched, current limited and fault detected by a MOSFET switch under software control. The current limiter allows momentary excursions above the nominal current limit to allow for KISS suction pump startup transients.

Untested "Nominal" Operating Time Specs

These specifications are affected by battery pack characteristics. While they are of interest, it is not possible to test them in production. These are "nominal specs" and are only guaranteed for a new battery pack of 3.5A capacity. As the following specs are for a system that is turned off, they are deliverable by the CPU regardless of other system components.

Nominal charge time:

5 Hours

Max off time from gauge full till loss of clock:	1 Month
Max off time from gauge just empty till loss of clock:	3 Days
Max off time from panic shutdown till loss of clock:	1 Day
Maximum time from removal of live battery to loss of clock:	6 Hours

6 Parts Lists and Drawings

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421117-001A Power Supply Assembly **18**

421114-002A Display Assembly **20**

900997-001C Trolley **24**

Ordering Parts

Introduction

The parts lists and assembly drawings in this chapter supply enough detail for you to order parts for the assemblies considered field serviceable. For component-level information, refer to the pcb assemblies chapter. See the appendices for information on assemblies used in previous configurations.

If you require additional information, schematic diagrams, or troubleshooting assistance, contact Tech Support.

To order parts, contact Service Parts at the address or telephone number on the, “How to Reach Us...,” page provided at the beginning of this manual.

Field Replaceable Units

The following items may not be assigned separate manufacturing part numbers because they are normally part of a larger assembly. Since they are considered field replaceable units (FRUs), they have specific service part numbers so they can be ordered and replaced by service technicians. Contact Tech Support for FRU information for assemblies used on previous configurations.

NOTE

Verify part numbers before ordering service parts (field replaceable units). See the tech memo series for this product for changes or additions to this list.

Table 6-1. Field Replaceable Units

Item	Part Number
Battery Assembly	900770-001
Power Supply Assembly	421117-001
PCB, MAC 5000 CPU*	801212-003
Keyboard Assembly, English*	421115-001
Disk Drive, 3.5 inch Laptop Floppy*	2001377-001
Display Assembly*	421114-002
Printhead	422397-001
Writer Assembly	421108-003
Roller Assembly	422396-002

* Replacement of these assemblies requires complete disassembly of the unit and should only be performed by a qualified service person. Return to factory, 48 hour turnaround, service is available for this product.

MAC 5000 Rev B Generic Assembly

Item Number	Description
MAC5000_DISPLAY	MAC 5000 DISPLAY PTO OPTION CLASS
421828-007	OPT ACT MAC 5000 COLOR DISPLAY
MAC5000_STARTER_KIT	MAC 5000 STARTER KIT PTO OPTION CLASS
900531-003	KIT STR MAC 5000 STD PPR
900531-004	KIT STR MAC 5000 A4 PPR
421828-001	OPT ACT MAC 5000 INTERP SW
MAC5000_COMM	MAC 5000 COMMUNICATION PTO OPTION CLASS
421828-002	OPT ACT MAC 5000 MODEM
421828-003	OPT ACT MAC 5000 FAX
421828-004	OPT ACT MAC 5000 REMOTE QUERY
MAC5000_SFTWR	MAC5000 SOFTWARE PTO OPTION CLASS
421828-005	OPT ACT MAC 5000 HI-RES SW
421828-006	OPT ACT MAC 5000 PHI-RES SW
MAC5000_MODEM	MAC 5000 COUNTRY MODEM PTO OPTION CLASS
901123-001	KIT MAC 5000 EXT MDM 19.2 120V
901148-005	KIT MC5000 MOD EXT 19.2 GER
901148-006	KIT MC5000 MOD EXT 19.2 UK
901148-007	KIT MC5000 MOD EXT 19.2 FRE
901148-008	KIT MC5000 MOD EXT 19.2 220V
901148-009	KIT MC5000 MOD EXT 19.2 SWE
901148-010	KIT MC5000 MOD EXT 19.2 SPA
901148-011	KIT MC5000 MOD EXT 19.2 ITA
901148-012	KIT MC5000 MOD EXT 19.2 ASTL
901148-013	KIT MC5000 MOD EXT 19.2 AUST
901148-014	KIT MC5000 MOD EXT 19.2 BAHR
901148-015	KIT MC5000 MOD EXT 19.2 BEL
901148-016	KIT MC5000 MOD EXT 19.2 CZEC
901148-017	KIT MC5000 MOD EXT 19.2 DEN

Item Number	Description
901148-018	KIT MC5000 MOD EXT 19.2 FINL
901148-019	KIT MC5000 MOD EXT 19.2 HUNG
901148-020	KIT MC5000 MOD EXT 19.2 ICEL
901148-021	KIT MC5000 MOD EXT 19.2 IRE
901148-022	KIT MC5000 MOD EXT 19.2 JAP
901148-023	KIT MC5000 MOD EXT 19.2 RUSS
901148-024	KIT MC5000 MOD EXT 19.2 MALY
901148-025	KIT MC5000 MOD EXT 19.2 MEX
901148-026	KIT MC5000 MOD EXT 19.2 NETH
901148-027	KIT MC5000 MOD EXT 19.2 NZEA
901148-028	KIT MC5000 MOD EXT 19.2 NOR
901148-029	KIT MC5000 MOD EXT 19.2 POL
901148-030	KIT MC5000 MOD EXT 19.2 PORT
901148-031	KIT MC5000 MOD EXT 19.2 SING
901148-032	KIT MC5000 MOD EXT 19.2 SAFR
901148-033	KIT MC5000 MOD EXT 19.2 SWIT
901148-034	KIT MC5000 MOD EXT 19.2 TURK
901148-035	KIT MC5000 MOD EXT 19.2 UKR
MAC5000_CAM14	MAC 5000 CAM14 PTO OPTION CLASS
901142-001	KIT CAM14 REST W/AHA ADAPT
901142-002	KIT CAM14 REST W/IEC ADAPT
MAC5000_KEYBRDS	MAC5000 KEYBOARD PTO OPTION CLASS
421115-001	KEYBOARD ASSY MACK 5000 ENG
421115-002	KEYBOARD ASSY GER MAC 5000
421115-003	KEYBOARD ASY FR MAC 5000
421115-004	KEYBOARD ASSY SPA MAC 5000
421115-005	KEYBOARD ASSY SWE MAC 5000
421115-006	KEYBOARD ASSY ITA MAC 5000
421115-008	KEYBOARD ASSY DUT MAC 5000
POWERCORDS	POWERCORD GENERIC PTO OPTION CLASS
80274-006	CORD PWR 125V 6FT STR

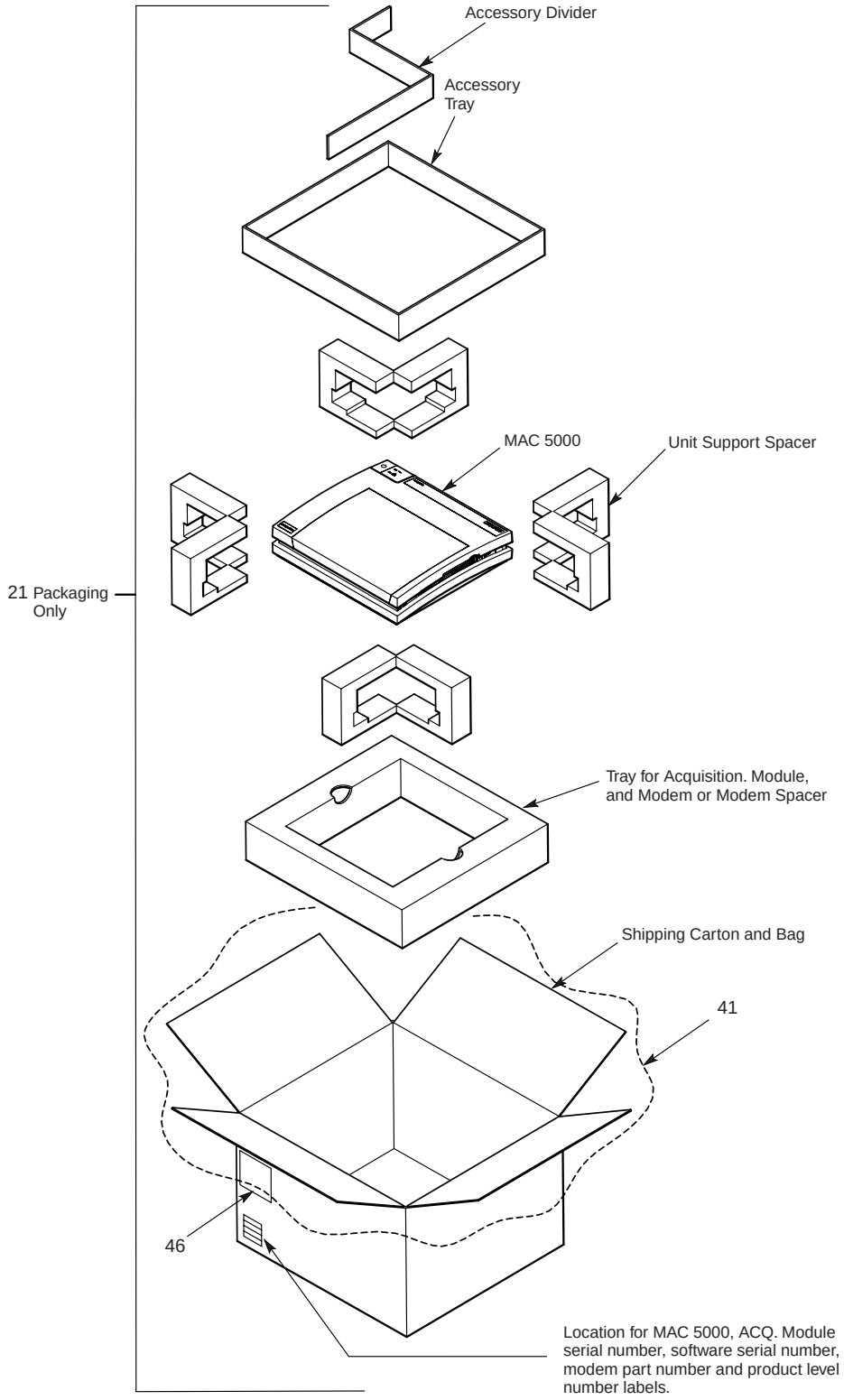
Item Number	Description
80274-004	CORD PWR 125V 6FT SE
401855-001	PWR CRD CONT EURO 10A 250V 8FT
401855-002	PWR CORD BRITISH 10A 250V 8FT
401855-003	PWR CORD ITALIAN 10A 250V 8FT
401855-004	PWR CORD ISRAELI 10A 250V 8FT
401855-005	WIRE HARNESS 10A 125V 6.5FT
401855-006	WIRE HARNESS 10A 250V 6.5FT
401855-007	PWR CORD SWISS 10A 250V 8FT
401855-008	PWR CORD INDIAN 10A 250V 8FT
401855-009	DANISH 220VAC/50HZ,STRESS
401855-010	PWR CORD AUSTRALN 10A 250V 8FT
401855-101	PWR CORD 10A 8FT CONT EURO STR
401855-102	PWR CORD 10A 8FT BRITISH STR
401855-103	PWR CORD ITALIAN 10A 8FT STR
401855-104	PWR CORD ISRAELI 10A 8FT STR
401855-107	PWR CORD SWISS 10A 8FT STR
401855-108	PWR CORD INDIAN 10A 8FT STR
401855-109	PWR CORD DANISH 10A 8FT STR
401855-110	PWR CORD AUST 10A 8FT STR
401855-201	POWER CORD 16A EURO
401855-202	POWER CORD 13A BRITISH
401855-203	POWER CORD 16A ITALIAN
401855-204	POWER CORD 16A ISRAELI
401855-210	POWER CORD 15A AUST
405535-002	CORD POWER STR 125V 15A 12FT
405535-006	CORD POWER RA 125V 13A 10FT
5509-001	CORD POWER 18-3 SJT
405535-001	POWER CORD RA 125V 13A 12F
414582-222	POWER ADAPTER 230VAC/DC ME
414582-224	POWER ADAPTER 240VAC/DC AA
414582-225	POWER ADAPTER 240VAC/DC UK

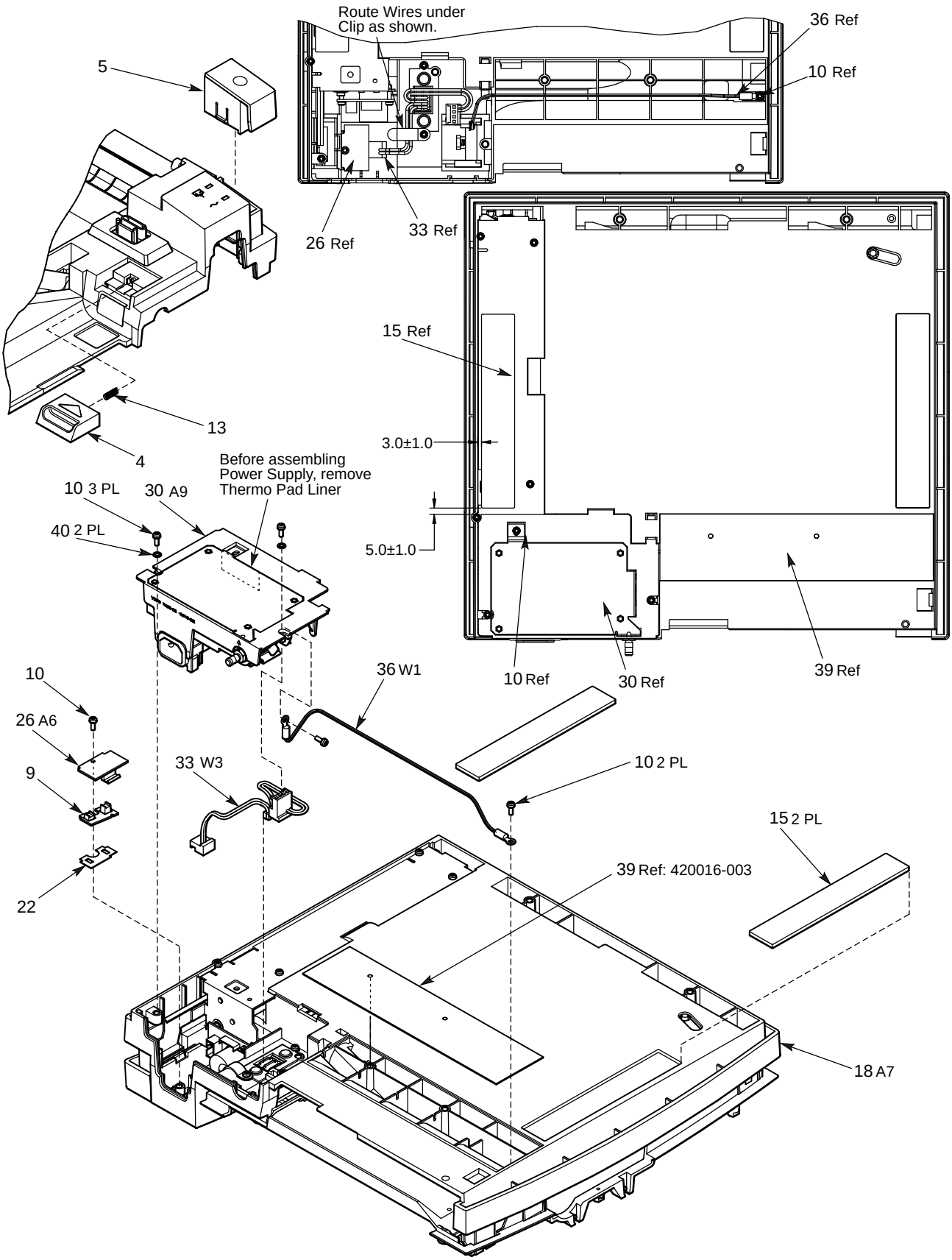
Item Number	Description
415359-001	PWR CRD EURO ADAPTER 1FT
414582-223	POWER ADAPTER 100VAC/DC JAP
MAC5000_MANUALS	MANUALS PTO OPTION CLASS MAC 5000
2000657-004	MNL OP MAC 5000 DUT
2000657-005	MNL OP MAC 5000 FRE
2000657-006	MNL OP MAC 5000 GER
2000657-007	MNL OP MAC 5000 ITA
2000657-008	MNL OP MAC 5000 SPA
2000657-009	MNL OP MAC 5000 SWE
2000657-001	MAC 5000 OP MANUAL
2000657-002	MAC 5000 FIELD SERVICE MANUAL
2002038-001	Video, MAC 5000
421783-007	INSERT OPTION MODEM MAC 5000
900769-001	ASSEMBLY MAC 5000
421384-003	MAC 5000 NAND CARD
416791-001	RESTING PHYS GUIDE

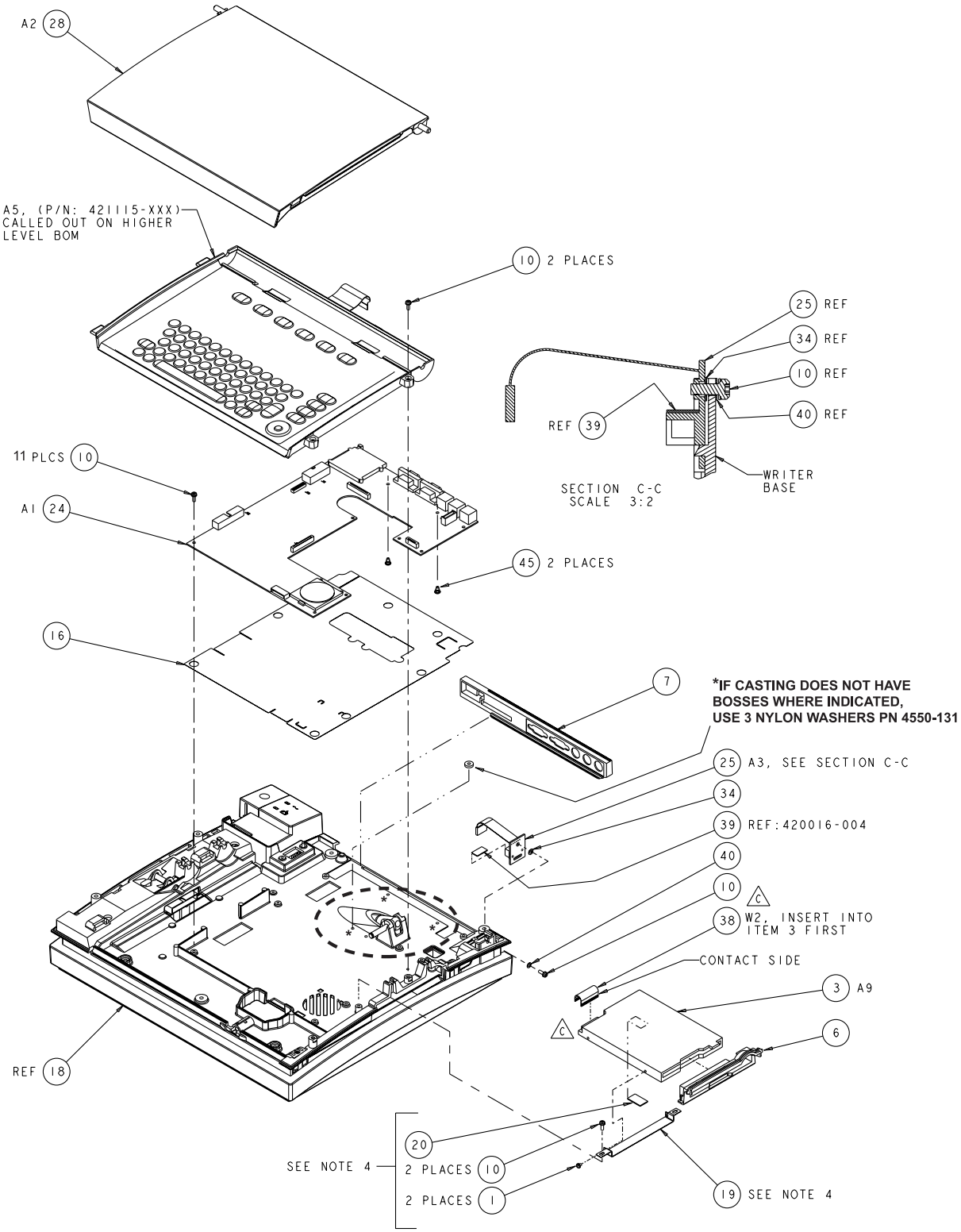
900769-001F Generic Assembly

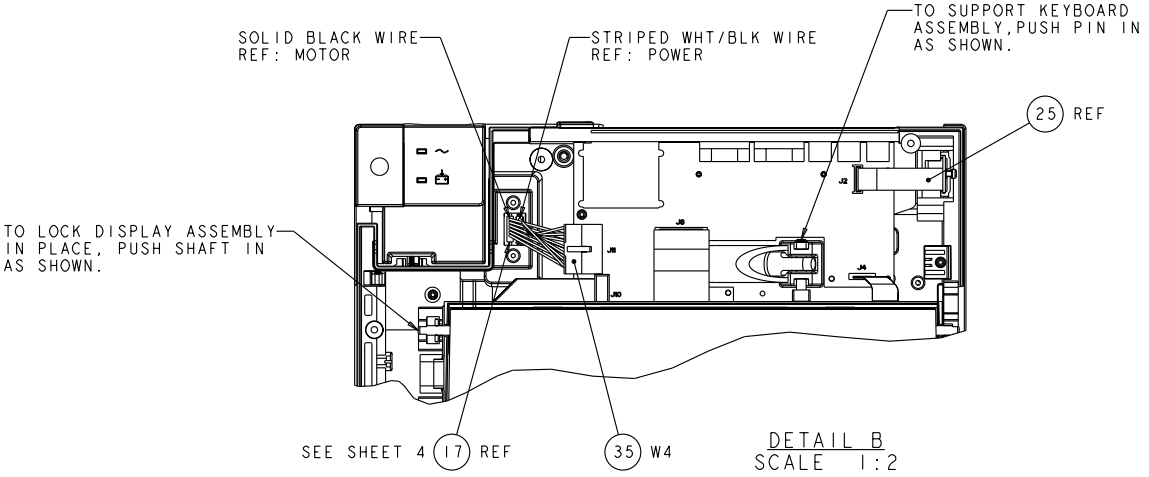
Find Num	Item Description	Item Number	Qty
1	SCREW MACHINE, PNHD, M2.6A X 3MM	2001785-001	2
2	COVER, TOP MAC 5000	416001-001	1
3	DISK DRIVE 3.5IN LAPTOP FLOPPY	2001377-001	1
4	BUTTON BATTERY MAC SERIES	416298-001	1
5	BUTTON, WRITER MAC SERIES	416406-001	1
6	DRIVE COVER MAC 5000	417468-002	1
7	PANEL CONNECTOR, MAC 5000	417471-001	1
8	BUTTON PANEL MAC 5000	417471-002	1
9	LIGHTPIPE MAC 5000	421178-001	1
10	M3 X 8MM TORX SEMS	418545-001	29
11	STOP PANEL BUTTON MAC SERIES	419210-001	1
12	SPRING BATTERY MAC SERIES	419752-001	1
13	SPRING, BAT. BUTTON MAC	419753-001	1
15	PAD BOTTOM MAC SERIES	419755-001	2
16	INSULATOR BD MAC SERIES	419759-001	1
17	CONN VERT MINI-DRAWER 14P J	419957-001	1
18	PRINTER THERMAL MAC SERIES	421108-003	1
19	BRACKET FLOPPY MAC SERIES	421110-002	1
20	PAD FLOPPY MAC SERIES	421193-001	1
21	KIT SHIPPING CARTON MAC 5000	421783-001	1
22	ADHESIVE LIGHTPIPE MAC SERIES	421195-001	1
23	CABLE COILED ASSY HOST AM11X	700657-001	1
24	PCB MAC 5000 CPU	801212-003	1
25	PCB MAC 5000 BATTERY TRANS	801220-001	1
26	PCB LED BOARD MAC 5000	801222-001	1
27	BATTERY PACK ASSY MAC PAC	900770-001	1
28	ASSY DISPLAY MAC 5000	421114-002	1
30	ASSY POWER SUPPLY MAC 5000	421117-001	1
31	LABEL SET MAC 5000	417567-001	1
33	HARNESS PS/LED/MOTOR	700645-001	1
34	WASH NYL .28 OD .12 ID .03 THK	4550-014	1
35	HARNESS PWR TO CPU BD	700682-001	1
36	HARNESS GROUND MAG MAC 5000	700686-001	1
37	CABLE ASSY PRTHD/SENSOR W/O FER	700687-002	1
38	CABLE FLAT RIBBON FLOPPY DRIVE	700688-001	1
39	LABEL SET MAC5000 BOTTOM COVER	420016-001	1
40	WASHER FLAT SS #4	4520-004	5
41	BAG POLY 22X22X47IN ANTI-STAT	421883-001	1

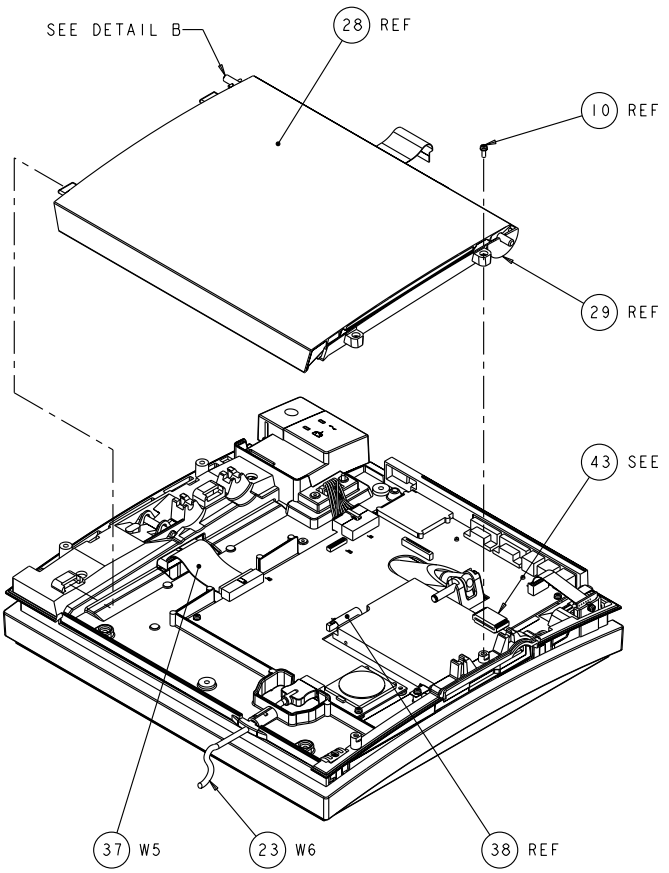
Find Num	Item Description	Item Number	Qty
42	LABEL CLEAR OVERLAMINATE	413608-001	1
43	CORE EMI SUPPR 100 OHM/100	413455-001	1
44	ADHESIVE BEZEL, CORNER	419740-002	1
46	LABEL CARTON MAC 5000	422159-001	1
48	KIT, GROUND CHAIN	2000702-001	1

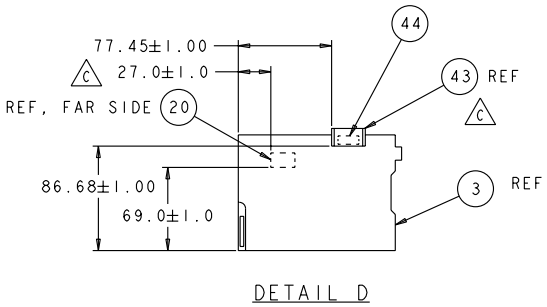

Accessory Divider
Accessory Tray
MAC 5000
Unit Support Spacer
21 Packaging Only
Tray for Acquisition. Module, and Modem or Modem Spacer
Shipping Carton and Bag
41
46
Location for MAC 5000, ACQ. Module serial number, software serial number, modem part number and product level number labels.

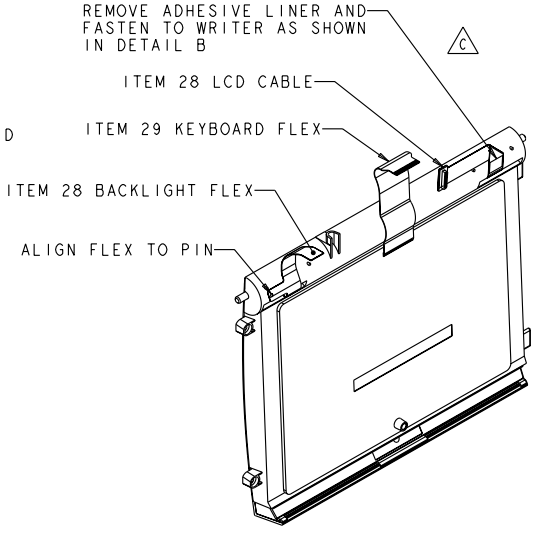

Route Wires under
Clip as shown.
36 Ref
10 Ref
5
26 Ref
33 Ref
15 Ref
13
3.0±1.0
4
Before assembling
Power Supply, remove
Thermo Pad Liner
10 3 PL
30 A9
40 2 PL
5.0±1.0
10
36 W1
10 Ref
30 Ref
39 Ref
26 A6
9
33 W3
10 2 PL
15 2 PL
39 Ref: 420016-003
22
18 A7

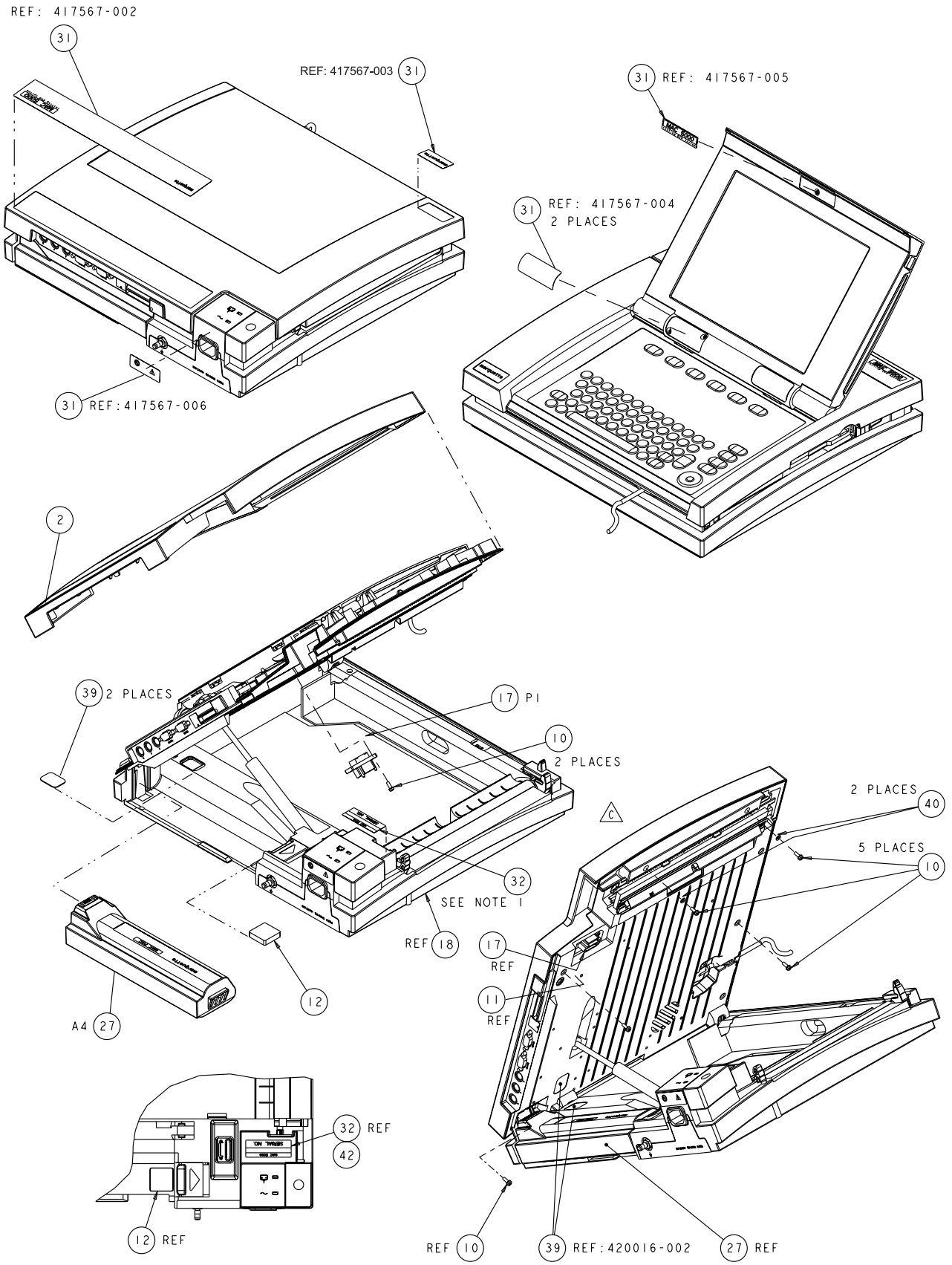

A2 28
A5, (P/N: 42111 5-XXX) CALLED OUT ON HIGHER LEVEL BOM
10 2 PLACES
25 REF
34 REF
10 REF
40 REF
REF 39
WRITER BASE
SECTION C-C
SCALE 3:2
11 PLCS 10
A1 24
45 2 PLACES
16
7
*IF CASTING DOES NOT HAVE BOSSES WHERE INDICATED, USE 3 NYLON WASHERS PN 4550-131
25 A3, SEE SECTION C-C
34
39 REF:420016-004
40
10 C
38 W2, INSERT INTO ITEM 3 FIRST
CONTACT SIDE
3 A9
6
REF 18
20
SEE NOTE 4
2 PLACES 10
2 PLACES 1
19 SEE NOTE 4

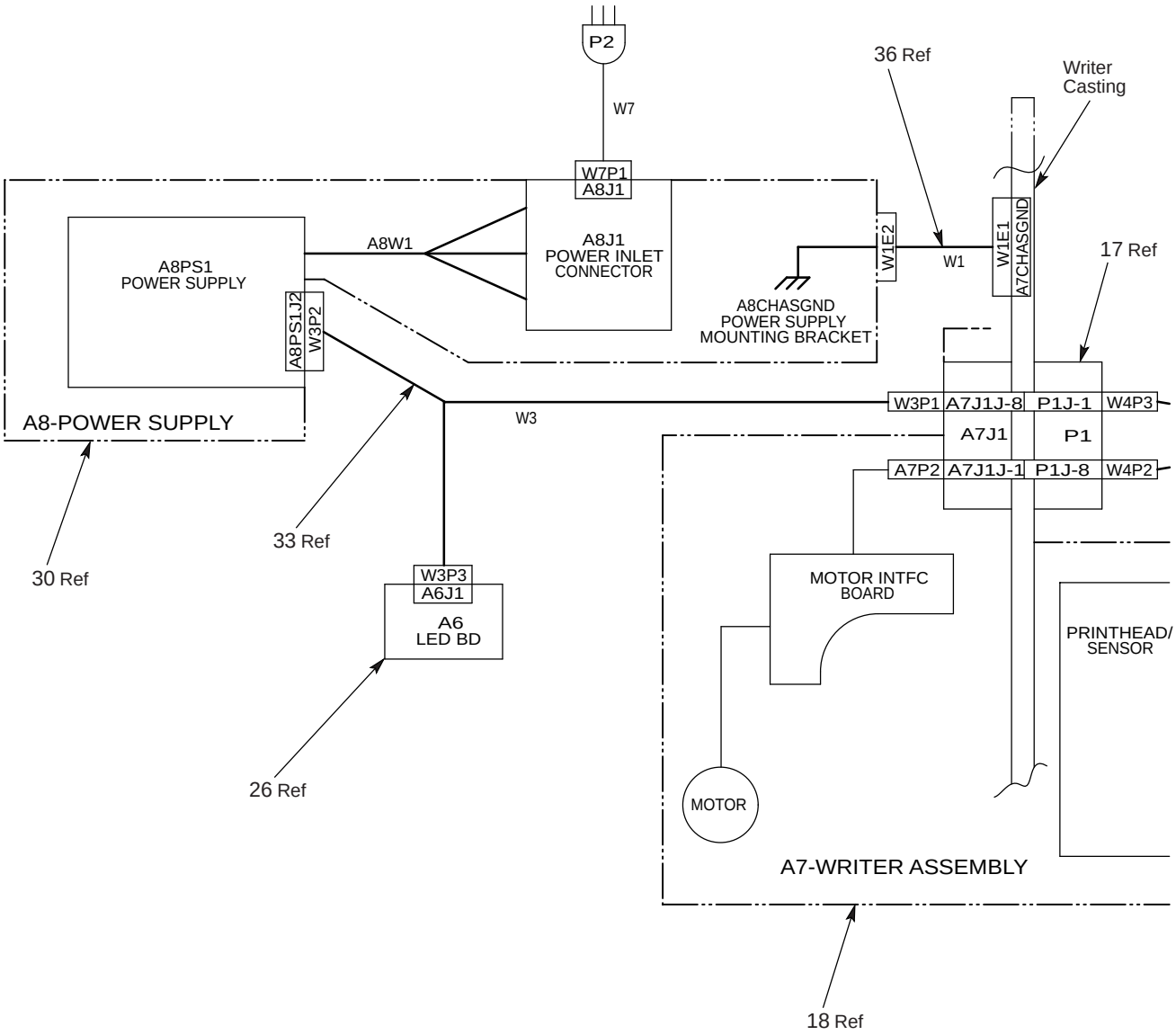

SOLID BLACK WIRE
REF: MOTOR
STRIPED WHT/BLK WIRE
REF: POWER
TO SUPPORT KEYBOARD ASSEMBLY, PUSH PIN IN AS SHOWN.
25 REF
TO LOCK DISPLAY ASSEMBLY IN PLACE, PUSH SHAFT IN AS SHOWN.
SEE SHEET 4
17 REF
35 W4
DETAIL B
SCALE 1:2

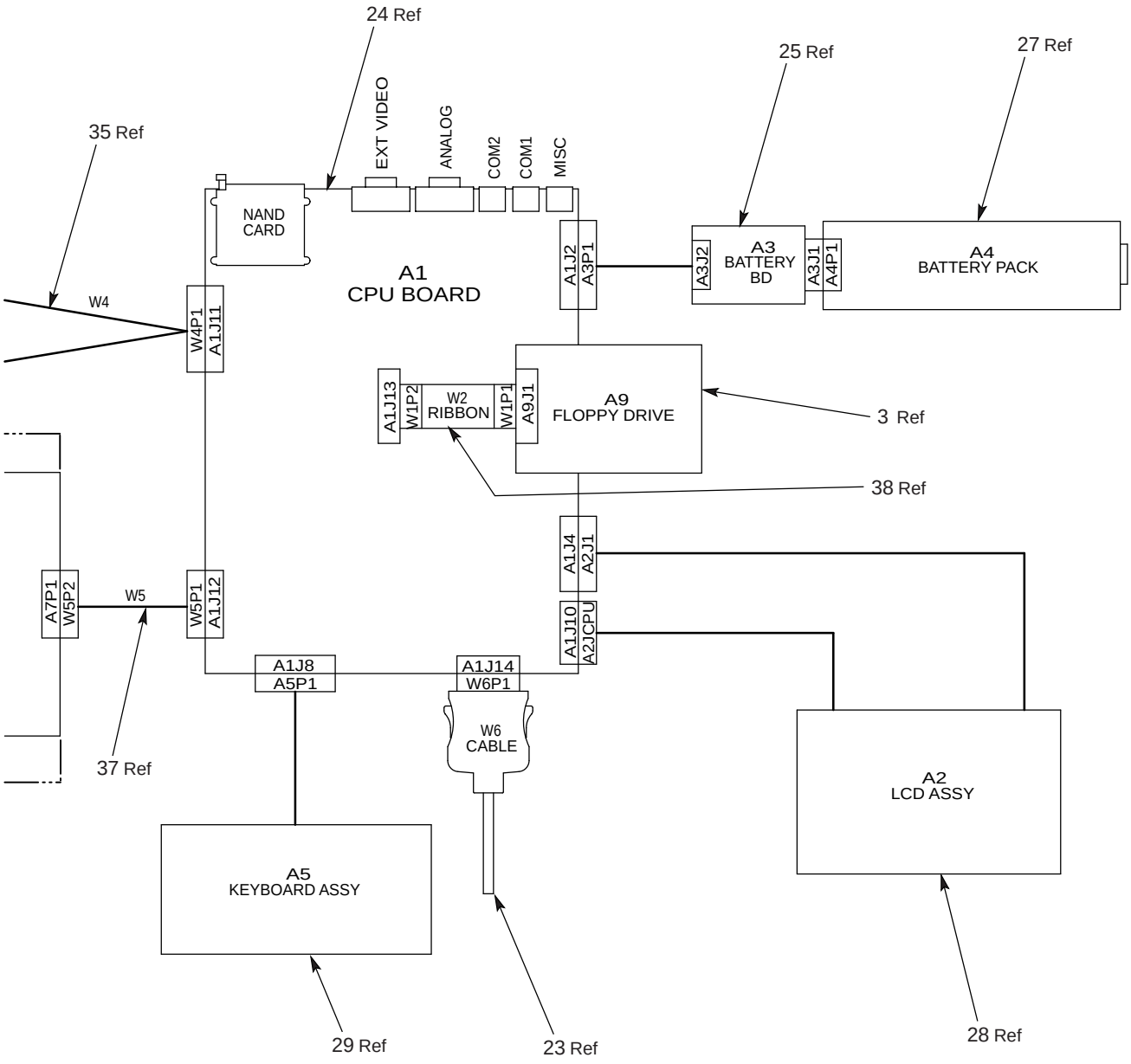

SEE DETAIL B
28 REF
10 REF
29 REF
43 SEE DETAIL D
37 W5
23 W6
38 REF


77.45±1.00
C
27.0±1.0
REF, FAR SIDE
20
44
43 REF
C
3 REF
86.68±1.00
69.0±1.0
DETAIL D


REMOVE ADHESIVE LINER AND FASTEN TO WRITER AS SHOWN IN DETAIL B
C
ITEM 28 LCD CABLE
ITEM 29 KEYBOARD FLEX
ITEM 28 BACKLIGHT FLEX
ALIGN FLEX TO PIN


REF: 417567-002
31
REF: 417567-003 31
31 REF: 417567-005
31 REF: 417567-004
2 PLACES
31 REF: 417567-006
2
39 2 PLACES
17 PI
10
2 PLACES
2 PLACES
40
5 PLACES
10
32
SEE NOTE 1
REF 18
17
REF
11
REF
12
A4 27
32 REF
42
12 REF
REF 10
39 REF: 420016-002
27 REF


P2
W7
W7P1
A8J1
A8J1
POWER INLET
CONNECTOR
A8W1
A8PS1
POWER SUPPLY
A8PS1J2
W3P2
A8-POWER SUPPLY
A8CHASGND
POWER SUPPLY
MOUNTING BRACKET
W1E2
W1
36 Ref
Writer
Casting
W1E1
A7CHASGND
17 Ref
W3P1
A7J1J-8
P1J-1
W4P3
A7J1
P1
A7P2
A7J1J-1
P1J-8
W4P2
W3
33 Ref
30 Ref
W3P3
A6J1
A6
LED BD
26 Ref
MOTOR INTFC
BOARD
PRINTHEAD/
SENSOR
MOTOR
A7-WRITER ASSEMBLY
18 Ref

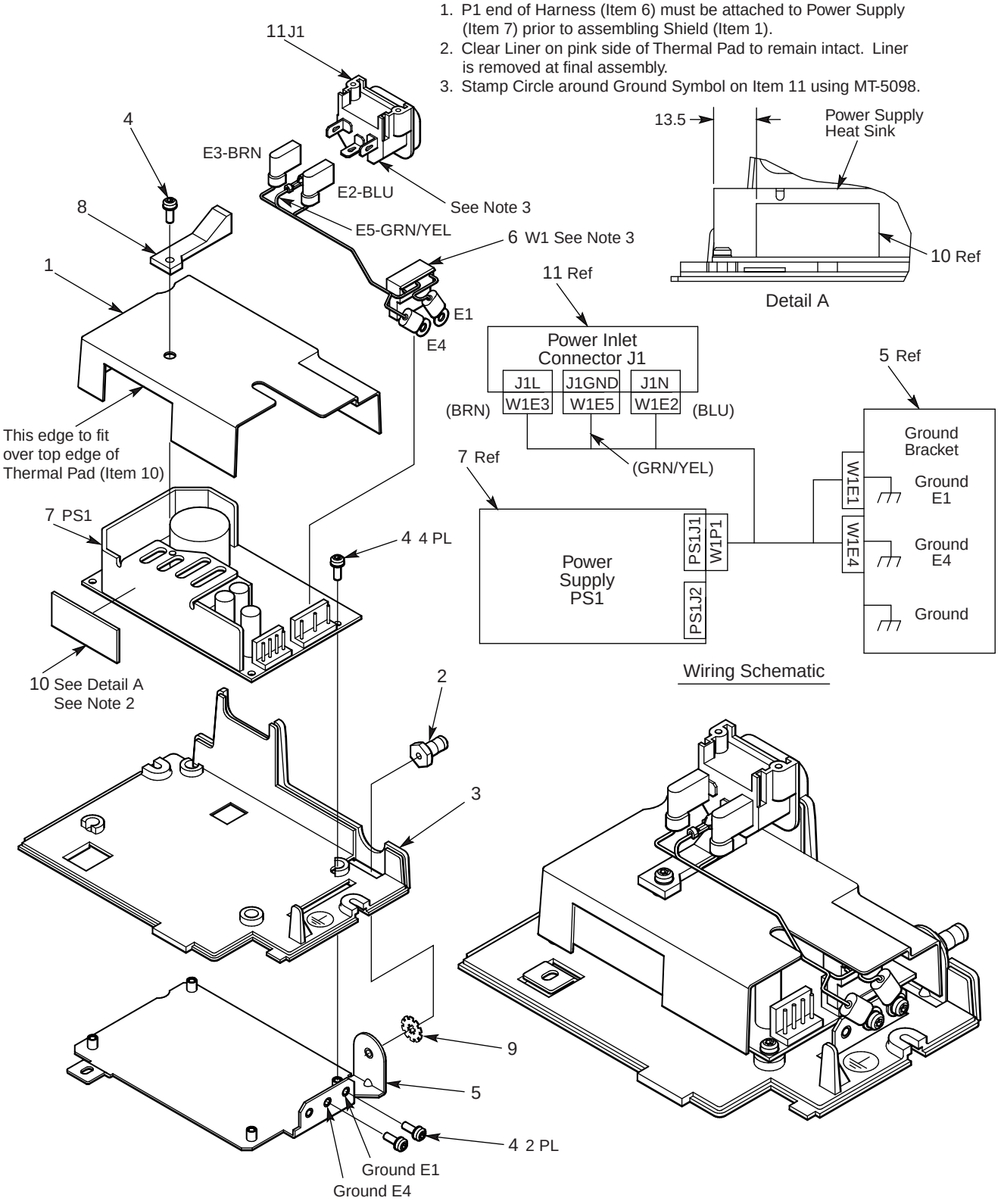

24 Ref
25 Ref
27 Ref
35 Ref
EXT VIDEO
ANALOG
COM2
COM1
MISC
NAND CARD
A1
CPU BOARD
A1J2
A3P1
A3J2
A3
BATTERY BD
A3J1
A4P1
A4
BATTERY PACK
W4
W4P1
A1J11
A1J13
W1P2
W2
RIBBON
W1P1
A9J1
A9
FLOPPY DRIVE
3 Ref
38 Ref
A1J4
A2J1
A7P1
W5P2
W5
W5P1
A1J12
A1J10
A2JCPU
A1J8
A5P1
A1J14
W6P1
W6
CABLE
37 Ref
A2
LCD ASSY
A5
KEYBOARD ASSY
29 Ref
23 Ref
28 Ref

421117-001A Power Supply Assembly

Find Num	Item Description	Item Number	Qty
1	SHIELD PWR SUPPLY MAC 5000	420751-001	1
2	PLUG M3 EQUIPOTENTIAL	400040-002	1
3	COVER POWER SUPPLY MAC SERIES	417470-001	1
4	M3 X 8MM TORX SEMS	418545-001	7
5	BRACKET POWER SUPPLY GROUND	419446-001	1
6	HARNESS POWER AC MAC 5000	700646-001	1
7	POWER SUPPLY +28V IA SWITCHER	419776-001	1
8	SUPPORT RIB PWR CONN MAC SER	420809-001	1
9	WASHER LOCK EXT/INT #4	4520-804	1
10	THRML PAD VO SOFT 39LX17WX1.5T	421467-001	1
11	CONN PWR INLET 15A 250V .187QC	420167-001	1

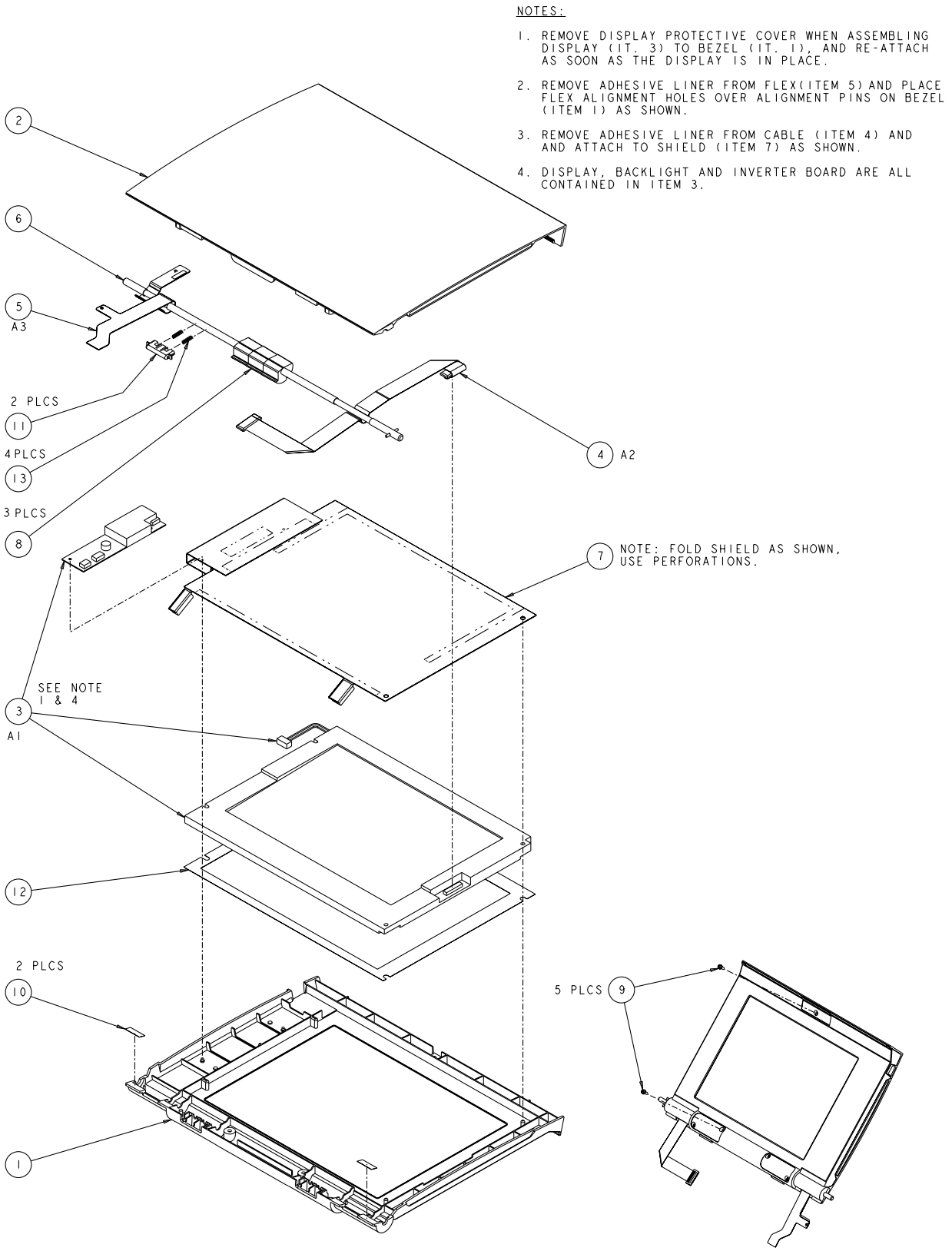
Notes:

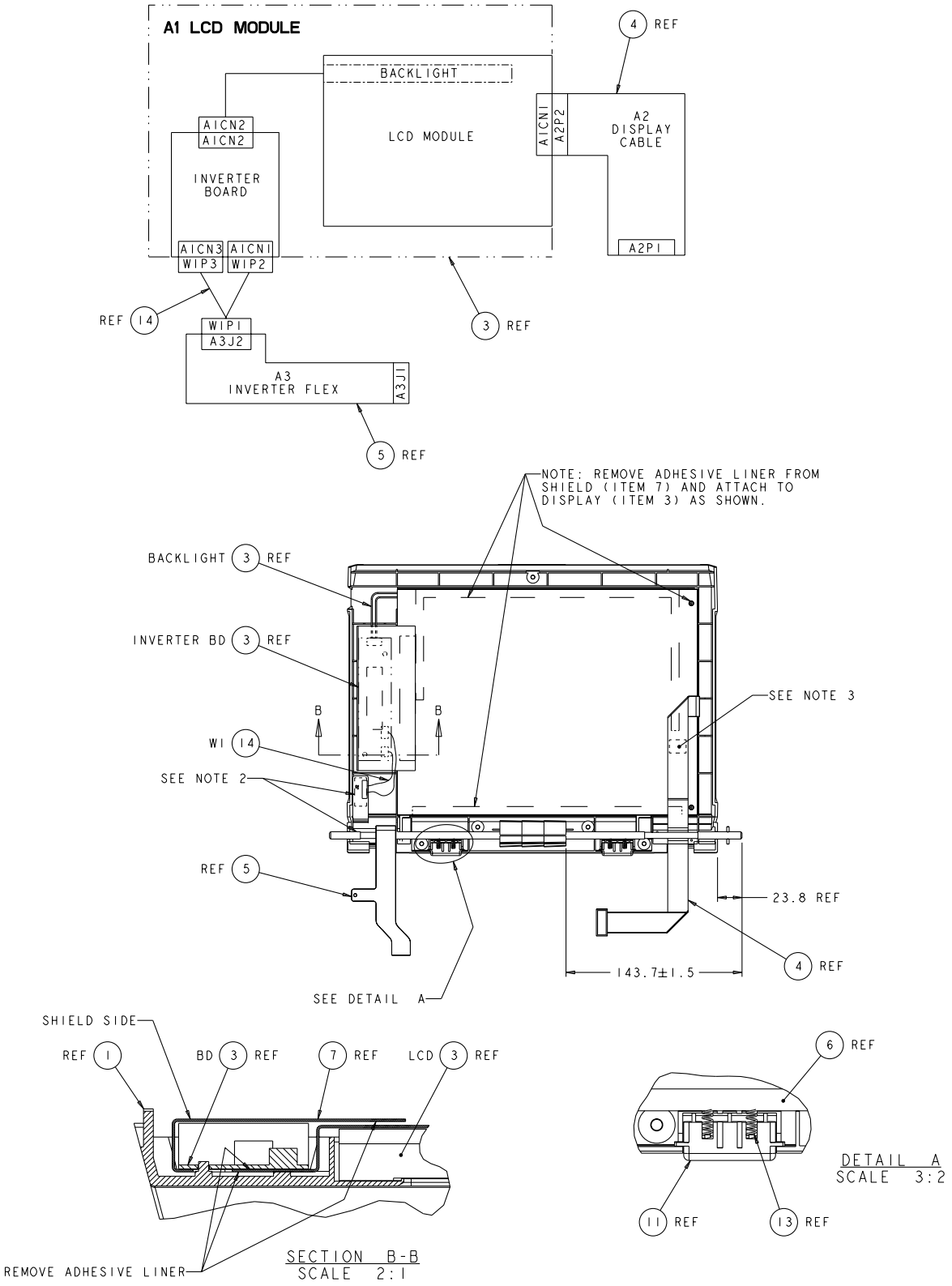
1. P1 end of Harness (Item 6) must be attached to Power Supply (Item 7) prior to assembling Shield (Item 1).
2. Clear Liner on pink side of Thermal Pad to remain intact. Liner is removed at final assembly.
3. Stamp Circle around Ground Symbol on Item 11 using MT-5098.



421114-002A Display Assembly

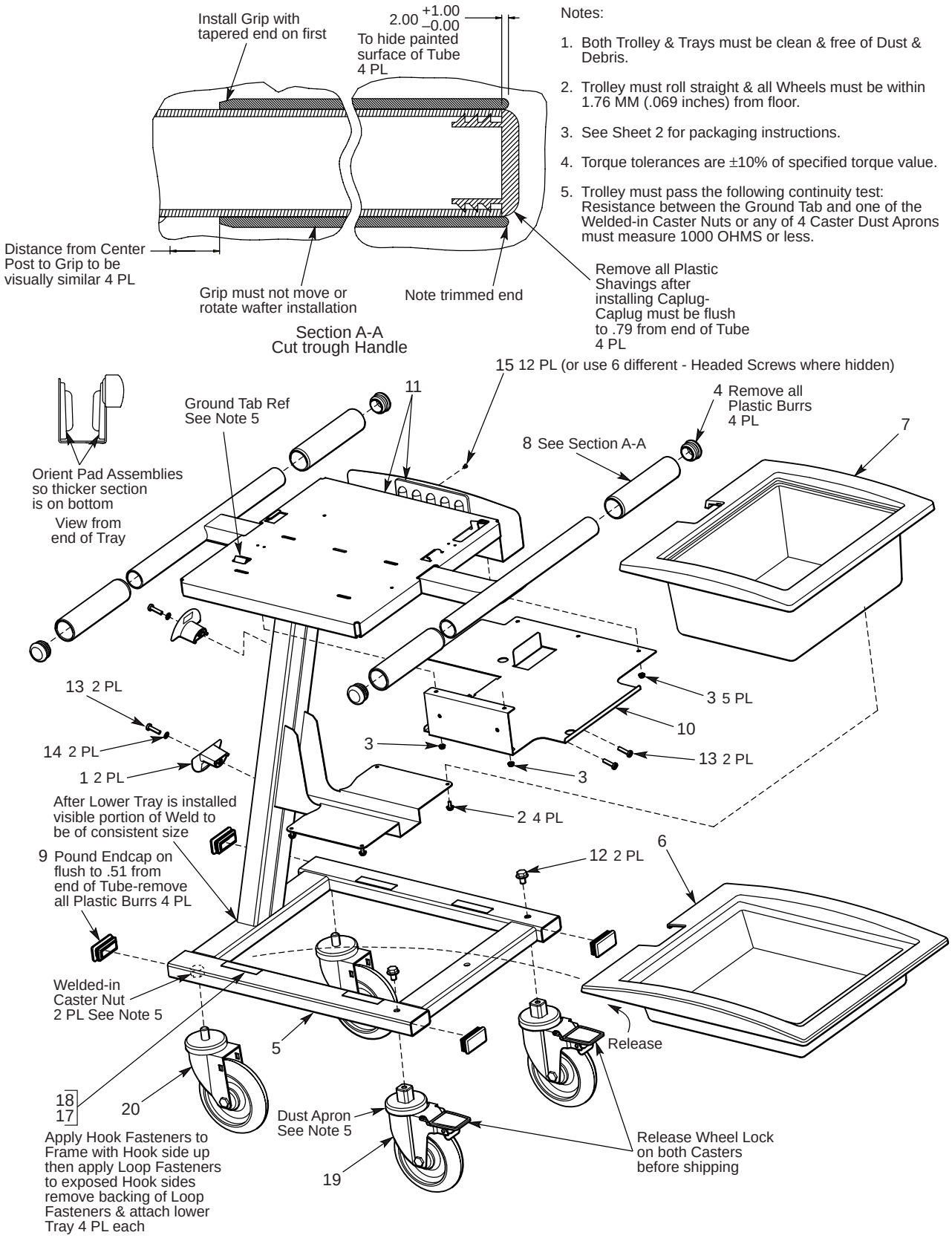
Find Num	Item Description	Item Number	Qty
1	BEZEL DISPLAY 10.5 DIAG	416003-001	1
2	COVER DISPLAY 10.5 DIAG	416004-001	1
3	DISPLAY COLOR 10.5 DIAG	416734-001	1
4	CABLE ASSY, DISPLAY, PCB MAC 5000	2001378-002	1
5	PCB MAC 5000 BACKLIGHT FLEX	801418-001	1
6	HINGE ROD, DISPLAY MAC 5000	417569-001	1
7	SHIELD EMI DISPLAY MAC 5000	421661-001	1
8	BUSHING HINGE DISPLAY	420887-001	3
9	M3 X 8MM TORX SEMS	418545-001	5
10	ADHESIVE BEZEL CORNER	419740-002	2
11	DETENT DISPLAY MAC 5000	419445-001	2
12	ADHESIVE BEZEL DISPLAY	419740-001	1
13	SPRING, DETENT MAC	419753-004	4
14	HARNESS INV BD TO FLEX	700683-001	1


NOTES:
1. REMOVE DISPLAY PROTECTIVE COVER WHEN ASSEMBLING DISPLAY (IT. 3) TO BEZEL (IT. 1), AND RE-ATTACH AS SOON AS THE DISPLAY IS IN PLACE.
2. REMOVE ADHESIVE LINER FROM FLEX(ITEM 5) AND PLACE FLEX ALIGNMENT HOLES OVER ALIGNMENT PINS ON BEZEL (ITEM 1) AS SHOWN.
3. REMOVE ADHESIVE LINER FROM CABLE (ITEM 4) AND AND ATTACH TO SHIELD (ITEM 7) AS SHOWN.
4. DISPLAY, BACKLIGHT AND INVERTER BOARD ARE ALL CONTAINED IN ITEM 3.
2
6
5
A3
2 PLCS
11
4 PLCS
13
3 PLCS
8
4
A2
7
NOTE: FOLD SHIELD AS SHOWN, USE PERFORATIONS.
SEE NOTE 1 & 4
3
A1
12
2 PLCS
10
1
5 PLCS
9


A1 LCD MODULE
BACKLIGHT
LCD MODULE
AICN2
AICN2
INVERTER BOARD
AICN3
WIP3
AICN1
WIP2
AICN1
A2P2
A2 DISPLAY CABLE
A2P1
4 REF
3 REF
REF 14
WIP1
A3J2
A3 INVERTER FLEX
A3J1
5 REF
NOTE: REMOVE ADHESIVE LINER FROM SHIELD (ITEM 7) AND ATTACH TO DISPLAY (ITEM 3) AS SHOWN.
BACKLIGHT 3 REF
INVERTER BD 3 REF
SEE NOTE 3
B
B
WI 14
SEE NOTE 2
REF 5
23.8 REF
143.7±1.5
4 REF
SEE DETAIL A
SHIELD SIDE
REF 1
BD 3 REF
7 REF
LCD 3 REF
REMOVE ADHESIVE LINER
SECTION B-B
SCALE 2:1
6 REF
11 REF
13 REF
DETAIL A
SCALE 3:2

900997-001C Trolley

Find Num	Item Description	Item Number	Qty
1	CORD WRAP	405661-005	2
2	SCREW SEMS M4-.7X10	411061-001	4
3	NUT HEX KEPS M4-.7 CLASS 8 ZP	411324-001	5
4	HOLE PLUG	419324-005	4
5	FRAME WELD MAC5000 TROLLEY	419352-100	1
6	TRAY LOWER MAC SYSTEM TROLLEY	419352-300	1
7	BIN-STORAGE MAC5000 TROLLEY	419352-400	1
8	GRIP HANDLE	419352-500	4
9	ENDCAP	419352-600	4
10	TRAY RPT MAC SYS TROLLEY	419352-702	1
11	PAD ASSY MAC SYS TROLLEY	419352-900	2
12	SCREW BINDING HEAD M8 X 12	420816-001	2
13	SCREW PH M5 X 20 POSIDRIV	420817-001	4
14	WASHER FLAT M5 DIN125A	420818-001	2
15	SCREW M3 X 4LG FLTHD N4.5 GREY	421581-001	12
16	PACKAGING MAC SYSTEM TROLLEY	421940-001	1
17	FSTNR HOOK.62X2.75	46006-001	4
18	FSTNR LOOP.62X2.75	46007-001	4
19	CASTER FIXED 5IN DIA MAC5000	4702-020	2
20	CASTER SWIVEL 5IN MAC 5000	4702-021	2
21	ADHESIVE LOCKTITE 425	4851-070	1


Install Grip with tapered end on first
2.00 +1.00 –0.00
To hide painted surface of Tube 4 PL
Distance from Center Post to Grip to be visually similar 4 PL
Grip must not move or rotate wafter installation
Note trimmed end
Remove all Plastic Shavings after installing Caplug- Caplug must be flush to .79 from end of Tube 4 PL
Section A-A
Cut trough Handle
Notes:
1. Both Trolley & Trays must be clean & free of Dust & Debris.
2. Trolley must roll straight & all Wheels must be within 1.76 MM (.069 inches) from floor.
3. See Sheet 2 for packaging instructions.
4. Torque tolerances are ±10% of specified torque value.
5. Trolley must pass the following continuity test: Resistance between the Ground Tab and one of the Welded-in Caster Nuts or any of 4 Caster Dust Aprons must measure 1000 OHMS or less.
15 12 PL (or use 6 different - Headed Screws where hidden)
11
Ground Tab Ref See Note 5
4 Remove all Plastic Burrs 4 PL
8 See Section A-A
7
Orient Pad Assemblies so thicker section is on bottom
View from end of Tray
13 2 PL
14 2 PL
1 2 PL
3 5 PL
10
3
13 2 PL
3
2 4 PL
After Lower Tray is installed visible portion of Weld to be of consistent size
9 Pound Endcap on flush to .51 from end of Tube-remove all Plastic Burrs 4 PL
12 2 PL
6
Welded-in Caster Nut 2 PL See Note 5
5
Release
18
17
20
Dust Apron See Note 5
19
Release Wheel Lock on both Casters before shipping
Apply Hook Fasteners to Frame with Hook side up then apply Loop Fasteners to exposed Hook sides remove backing of Loop Fasteners & attach lower Tray 4 PL each

7 PCB Assemblies

801212-003A	**CPU PCB Assembly**	**3**
SD801212-003A	**CPU**	**10**
801220-001B	**Battery Transition PCB**	**26**
SD801220-001A	**Battery Transition**	**27**
801222-001A	**LED PCB**	**28**
SD801222-001A	**LED**	**29**
2001326-001A	**Motor Protect PCB**	**31**
2001326-001A	**Motor Protect**	**32**

801212-003A CPU PCB Assembly

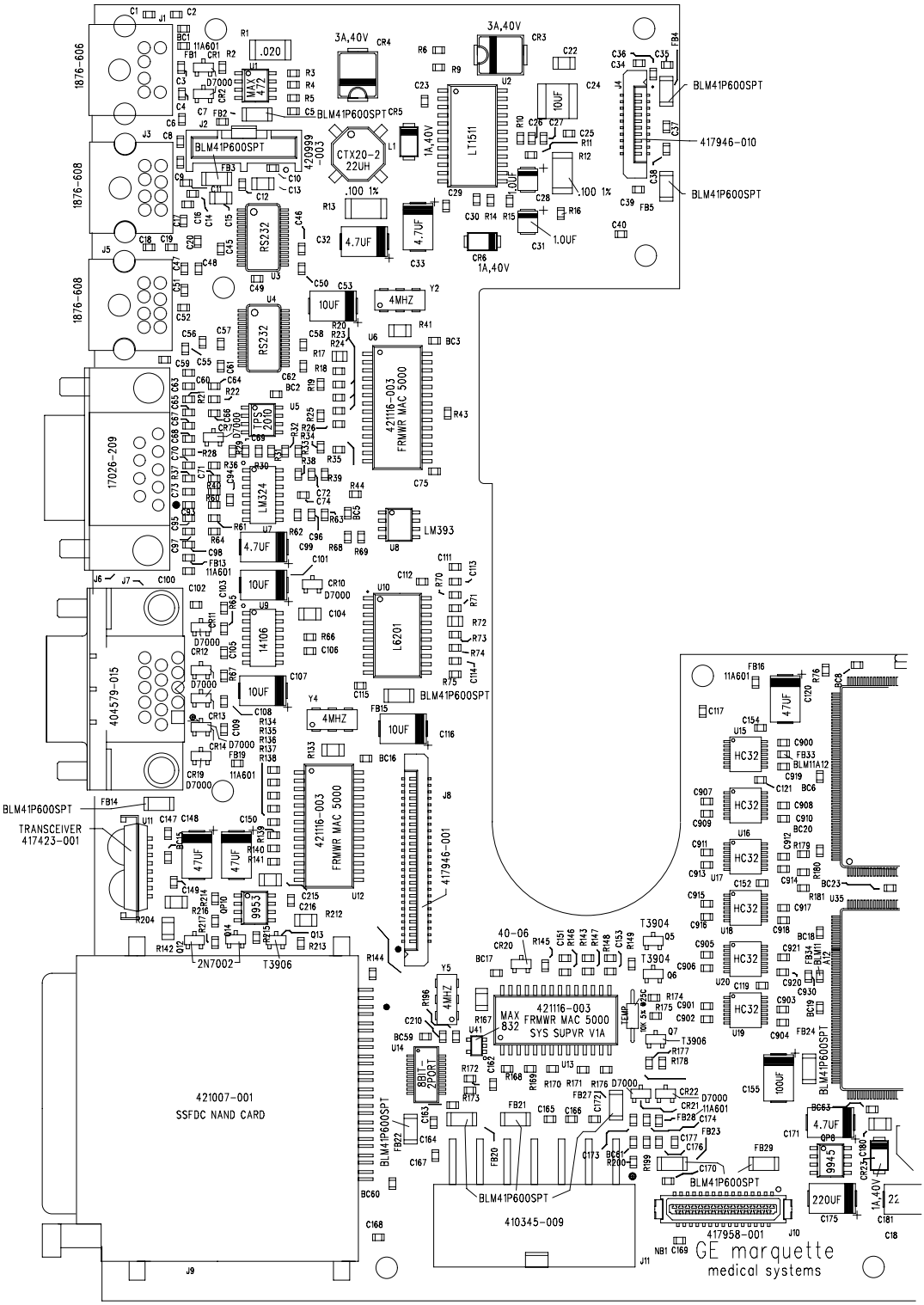
Find Num	Item Number	Item Description	Ref Des	Qty
1	1081-106	RES SM CER 10M 5% 1/8W	R41,R121,R133,R166,R167	5
2	1082-870	RES SM CHIP 20.0 1% 1/8W	R100	1
3	1082-919	RES SM CER 3.48K 1% 1/8W	R48,R91,R93,R109	4
4	1082-936	RES SM CER 536 1% 1/8W	R83,R90,R95	3
5	1082-937	RES SM CER 825 1% 1/8W	R81,R97,R112	3
6	1082-956	RES SM CER 1.74K 1% 1/8W	R92,R98,R111	3
7	1082-969	RES SM CER 432 1% 1/8 W	R79,R96,R113	3
8	1085-153	RES SM CHIP 15K 1% 1/10W	R89,R106,R107	3
9	1085-492	RES SM CHIP 4.99K 1% 1/10W	R17,R72,R161,R165,R183	5
10	1085-752	RES SM CHIP 7.5K 1% 1/10W	R94,R99,R108	3
11	1123-001	CAP SM TANT 68UF 10% 6V	C136,C137	2
12	1174-107	CAP SM TANT 100UF 20% 16V	C155 - 157, C182, C188,C189	6
14	1176-475	CAP SM TANT 4.7UF 20% 16V	C179	1
15	1187-104	CAP SM CER X7R .1UF 50V	C13,C15,C22,C80, C81, C92, C104, C141, C143, C144, C146, C180, C195, C209, C215	15
16	1663-004	SPEAKER 8 OHM .2W	SPKR	1
17	17026-209	CONN RCPT RT ANG 9P W/RIVETS	J6	1
18	1876-606	CONN MIN DIN PC MT 6P W/FERRIT	J1	1
19	1876-608	CONN MIN DIN PC MT 8P W/FERRIT	J3, J5	2
20	2013-201	DIODE SM SERIES PR D7000	CR1, CR2, CR7, CR10, CR11, CR12, CR13, CR14, CR19, CR21, CR22	11
21	2052-001	DIODE SM SCHOTTKY BAS 40-06	CR9, CR20, CR24, CR27	4
22	2052-002	DIODE SM SCHOTTKY BAS 40-04	CR17, CR18	2
23	2511-001	TRANSISTOR SM NPN T3904	Q3, Q4, Q5, Q6, Q10, Q11	6
24	2511-101	TRANSISTOR SM PNP T3906	Q1, Q2, Q7, Q9, Q13	5
25	2701-953	PFET SM PAIR SI9953	QP1, QP7, QP10	3
26	3038-014	IC SM HC 74HC14	U24	1
27	3122-009	IC SM REF 2.5V LM4040	U40	1

Find Num	Item Number	Item Description	Ref Des	Qty
28	3144-324	IC SM AMPL LM324	U7	1
29	3144-393	IC SM COMP LM393	U8, U21	2
30	400080-002	IC SM 1A DRVR H-BRIDGE L6201	U10	1
31	402085-001	CRYSTAL OSCILL SM 32.768 KHZ	Y3	1
32	402821-001	IC SM AC 74AC257	U28, U29	2
33	403026-001	RES SM CER 3.3 5% 1/4W	R57, R142, R204	3
34	403187-001	DIODE SM SCHOTTKY 1-AMP 40V	CR5, CR6, CR23, CR25, CR26	5
35	403800-002	FERRITE BEAD SM BLM41P600SPT	FB2, FB3, FB4, FB5, FB6, FB7, FB8, FB14, FB15, FB18, FB20, FB21, FB22, FB23, FB24, FB27, FB29, FB30, FB32	19
36	403907-001	CAP SM TANT 1.0UF 10% 35V	C28, C31, C213	3
37	404327-001	DIODE ZENER SM BZX84C6V8L	Z1, Z520	2
38	404579-015	CONN RCPT RA PC MT 15P 3 ROW	J7	1
39	405585-001	CAP SM TANT 47UF 20% 10V	C120	1
40	406884-013	CAP SM TANT 10UF 10% 35V	C53, C101, C107, C116, C145	5
41	407461-026	HEADER 4-WALL RT ANGLE LP 26P	J12	1
42	408880-001	DIODE SM RECT SHOTTKY 3A 40V	CR3, CR4	2
43	410238-001	IC SM CMOS 14106	U9	1
44	410334-003	RES SM 0603 100 1% 1/16W	R2, R4, R28, R29, R50, R56, R58, R60, R61, R64, R70, R114, R178	13
45	410334-008	RES SM CER 0603 1K 1% 1/16W	R10, R40, R43, R54, R76, R105, R123, R129, R130, R164, R179, R180, R181, R185, R186, R191, R192, R197, R215	19
46	410334-009	RES SM 0603 2K 1% 1/16W	R53, R73, R74	3
47	410334-013	RES SM CER 0603 10K 1% 1/16W	R6, R18, R44, R59, R71, R75, R84, R118, R119, R120, R122, R124, R132, R134, R135, R136, R137, R138, R139, R140, R141, R143, R144, R146, R148, R151, R152, R153, R154, R155, R156, R160, R168, R169, R170, R171, R172, R175, R182, R195, R199, R200, R201, R203, R214, R245	46
48	410334-019	RES SM 0603 100K 1% 1/16W	R5, R21, R30, R31, R37, R38, R45, R46, R51, R52, R62, R68, R85, R86, R87, R88, R173, R176, R190, R193, R194, R210, R216	23
49	410334-031	RES SM 0603 10 OHM 1% 1/16W	R158, R159	2
50	410334-034	RES SM 0603 511 OHM 1% 1/16W	R16	1

Find Num	Item Number	Item Description	Ref Des	Qty
51	410334-038	RES SM 0603 80.6K 1% 1/16W	R24, R26, R34	3
52	410334-040	RES SM 0603 49.9 OHM 1% 1/16W	R157	1
53	410334-044	RES SM 0603 200 OHM 1% 1/16W	R14, R15, R25, R49, R69, R77, R78, R117, R125, R127, R150, R162, R196	13
54	410334-053	RES SM 0603 20.0K 1% 1/16W	R19, R20, R23, R116, R211	5
55	410334-061	RES SM 0603 75 OHMS 1% 1/16W	R65, R67, R82, R101, R102, R103, R104, R110	8
56	410334-063	RES SM CER 0603 75K 1%	R131, R147, R217	3
57	410334-066	RES SM CER 0603 4.99K 1%	R9, R11, R145, R149, R174, R177, R198, R213	8
58	410334-078	RES SM CER 0603 2.74K 1%	R3	1
59	410334-120	RES SM 0603 1.0M 1%	R202	1
60	410334-134	RES SM 0603 13.3K 1% 1/16W	R35	1
61	410334-165	RES SM 0603 33.2K 1% 1/16	R22, R32, R33, R36, R39, R63, R66, R115	8
62	410345-009	CONN HDR RA MINIFIT W/PEGS 14P	J11	1
63	411575-002	CAP SM X7R 0603 .1UF 10%	BC1, BC2, BC3, BC4, BC5, BC6, BC7, BC8, BC9, BC10, BC11, BC12, BC13, BC14, BC15, BC16, BC17, BC18, BC19, BC20, BC21, BC22, BC23, BC24, BC25, BC26, BC27, BC28, BC29, BC30, BC31, BC32, BC33, BC34, BC35, BC36, BC37, BC38, BC39, BC40, BC41, BC42, BC43, BC44, BC45, BC46, BC47, BC48, BC49, BC50, BC51, BC52, BC53, BC54, BC55, BC56, BC57, BC58, BC59, BC60, BC61, BC62, BC63, BC64, BC65, BC66, BC67, BC68, BC69, C5, C12, C23, C26, C27, C35, C36, C37, C38, C44, C45, C46, C49, C50, C57, C58, C61, C62, C65, C67, C72, C73, C74, C75, C76, C77, C79, C93, C94, C96, C97, C108, C111, C115, C119, C121, C124, C125, C126, C128, C129, C130, C131, C138, C139, C151, C152, C153, C154, C166, C167, C170, C172, C173, C177, C184, C185, C190, C210, C211, C216	130
64	411575-012	CAP SM X7R 0603 0.01UF 5% 50V	C69, C106, C112, C113, C114, C127, C133, C134, C135, C178, C187, C212	12
65	411576-001	CAP SM NPO 0603 12PF 5% 50V	C159, C160	2
66	411576-008	CAP SM NPO 0603 47PF 5% 50V	C900, C901, C902, C903, C904, C905, C906, C907, C908, C909, C910, C911, C912, C913, C914, C915, C916, C917, C918, C919, C920, C921, C930, C931	24

Find Num	Item Number	Item Description	Ref Des	Qty
67	411576-009	CAP SM NPO 0603 150PF 5%	C78, C85, C88, C122, C205	5
68	411576-018	CAP SM NPO 0603 470PF 5% 50V	C1, C2, C3, C4, C6, C7, C8, C9, C10, C11, C14, C16, C17, C18, C19, C20, C25, C29, C30, C34, C39, C40, C41, C42, C43, C47, C48, C51, C52, C55, C56, C59, C60, C63, C64, C66, C68, C70, C71, C82, C83, C84, C95, C98, C100, C102, C103, C105, C109, C117, C123, C147, C149, C158, C162, C163, C164, C165, C168, C169, C174, C176, C183, C191, C192, C196, C197, C198, C202, C203, C204, C206, C207, C208	74
69	412010-001	SM RESONATOR 4MHZ TYPE KBR	Y1, Y2, Y4, Y5	4
70	412110-001	CAP GOLD .22F 5.5V -20%/+80%	C199	1
71	413134-001	XSTR DUAL MOSFET N-CH SI9945DY	QP8, QP9	2
72	413233-001	XSTR SM DUAL NPN IMX1	QP2, QP3, QP4, QP5, QP6	5
73	414061-001	SM FERRITE BEAD 0603 BLM11A601	FB1, FB9, FB10, FB11, FB12, FB13, FB16, FB17, FB19, FB28, FB31, FB36, FB37, FB38, FB39	15
74	415051-020	RES SM METAL WSL-2512 .020 1%	R1, R184, R188	3
76	415800-001	INDUCTOR/XFMR SM CTX20-2 20UH	L1	1
77	416171-001	FERRITE BEAD 0603 BLM11A12	FB33, FB34	2
78	417036-001	INDUCTOR SM 22UH	L2, L3	2
79	417423-001	SMT IRDA COMPLIANT TRANCEIVER	U11	1
80	417560-001	IC SM STRONG CPU SA-110	U32	1
81	417576-001	IC SM FPGA XC4013XL-2PQ208C	U23	1
82	417577-001	IC SM PC87306 SUPER I/O	U34	1
83	417876-001	IC SM FLAT PANEL CONT F65548A	U35	1
84	417877-001	OSC W/EN SM 24.000 MHZ 3.3V	OSC1	1
85	417880-001	IC SM REG MAX604 3.3V SO8	U27	1
86	417900-001	XFMR S, 2PRI/1SEC 10 PIN	T2	1
87	417903-001	IC SM CMOS MUX/DEMUX	U30	1
88	417909-001	IC MAX782 PS CNTRLR SSOP	U39	1
89	417910-001	IC PWR DIST SWITCH TPS2010	U5	1
90	417913-001	IC RS485/422 XCVR MAX490 SO8	U22	1
91	417914-001	IC SM MAX213E +5V RS232 XCVR	U3, U4	2
92	417946-001	CONN SM VERT FFC 1MM 26 POS	J8, J13	2

Find Num	Item Number	Item Description	Ref Des	Qty
93	417946-010	CONN SM VERT FFC 1MM 10 POS	J4	1
94	417958-001	CONN HEADER 1MM SM VERT 31P	J10	1
95	417967-001	NTC THERMISTOR 10K 5% @ 25C	TEMP	1
96	419250-001	IC SM BATTERY CHGR LT1511	U2	1
97	419606-001	IC SM MOSFET SI4450DY N-CHAN	Q8	1
98	419699-002	IC SM PWR SPLY MONMAX823	U41	1
99	419708-001	IC SM SERIAL E2 PROM X25128	U31	1
100	419787-001	CONN RCPT SM 0.8MM 10P	J14	1
101	419955-001	SW REG +12V 1.5A PT78ST112H	U26	1
102	419956-001	RES SM METAL WSL-2512 .100 1%	R12, R13, R47	3
103	420999-003	HDR VERT .1 CTR W/LATCH 6P	J2	1
104	421006-001	IC SM 8BIT 2PORT SW QSOP	U14	1
105	421007-001	SOCKET SM SSFDC NAND CARD 3.3V	J9	1
106	421081-001	IC SM I-SENSE AMP MAX472	U1	1
107	421082-001	CAP SM CERAMIC 10UF 50V	C24	1
109	421123-001	FIRMWR DRAM LOGIC	U37	1
110	421177-001	IC SM DRAM 1MX16 3.3V EDO	U33, U36, U38	3
111	422056-001	IC SM TSSOP 74HC32	U15, U16, U17, U18, U19, U20	6
112	801213-001	CKT BD MAC 5000 CPU		1
113	SD801212-003	SCHEM 1212 BRD		0
114	421116-003	FIRMWR MAC 5000 SYS SUPVR V1A	U6, U12, U13, U25	4
115	402414-001	TRANSISTOR SM FET NCHAN 2N7002	Q12, Q14	2
116	402414-001	CAP SMTANT 4.7UF 10% 50V	C32, C33, C99, C140, C142, C171, C186, C194	8
117	411698-001	CAP SM TANT 47UF	C148, C150, C200, C201	4
118	411907-001	RES SM CER 1.50 5%	R212	1
119	412662-002	CAP SM TANT 220UF	C132, C175, C181, C214	4

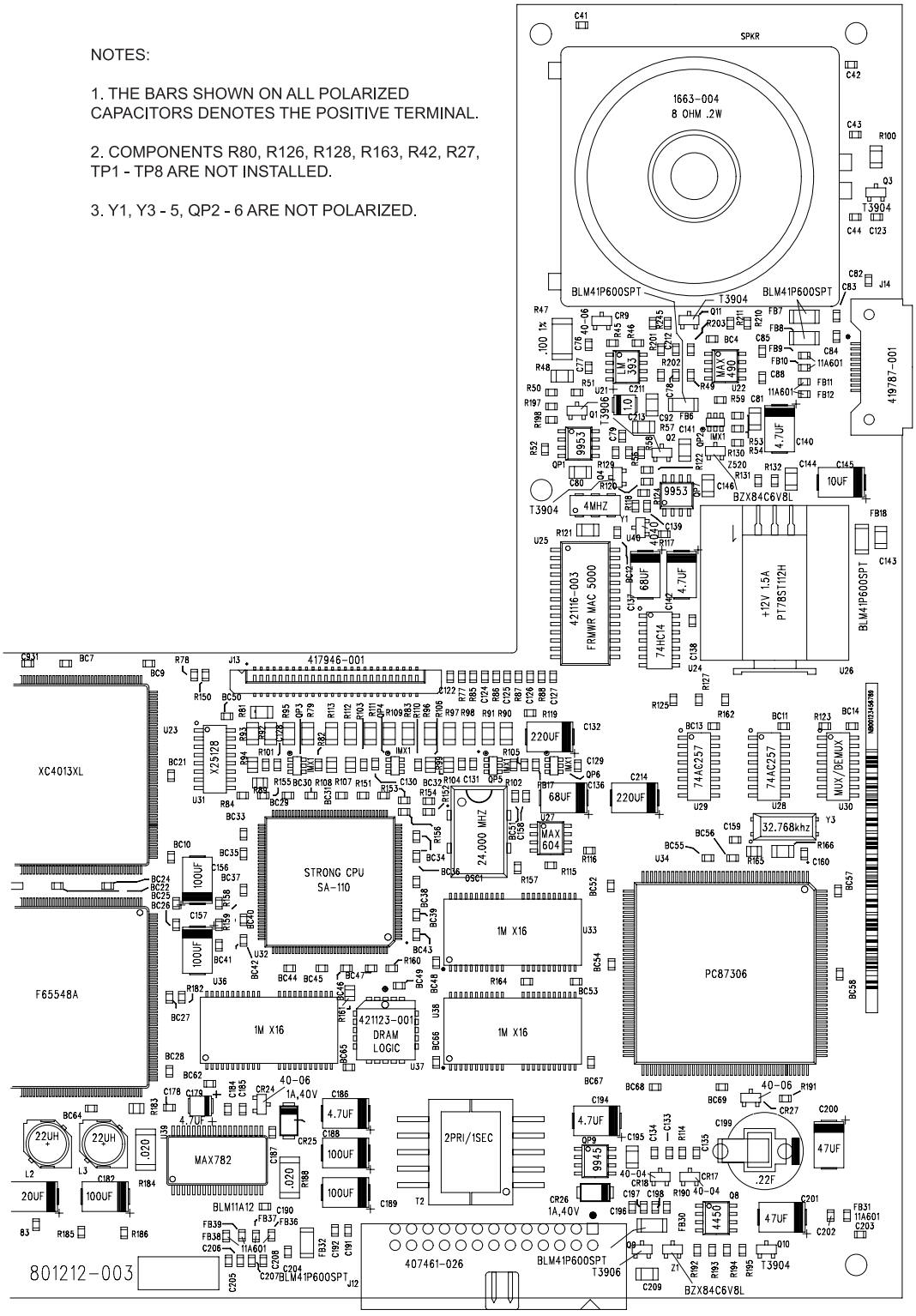

421007-001
SSFDC NAND CARD
410345-009
417946-001
417946-010
417423-001
TRANSCEIVER
404579-015
17026-209
1876-606
1876-608
1876-608
BLM41P600SPT
421116-003
FRMWR MAC 5000
421116-003
FRMWR MAC 5000
SYS SUPVR V1A
MAX 832
LT1511
CTX20-2
22UH
LM324
LM393
L6201
RS232
RS232
TPS2010
417958-001
GE marquette
medical systems

NOTES:

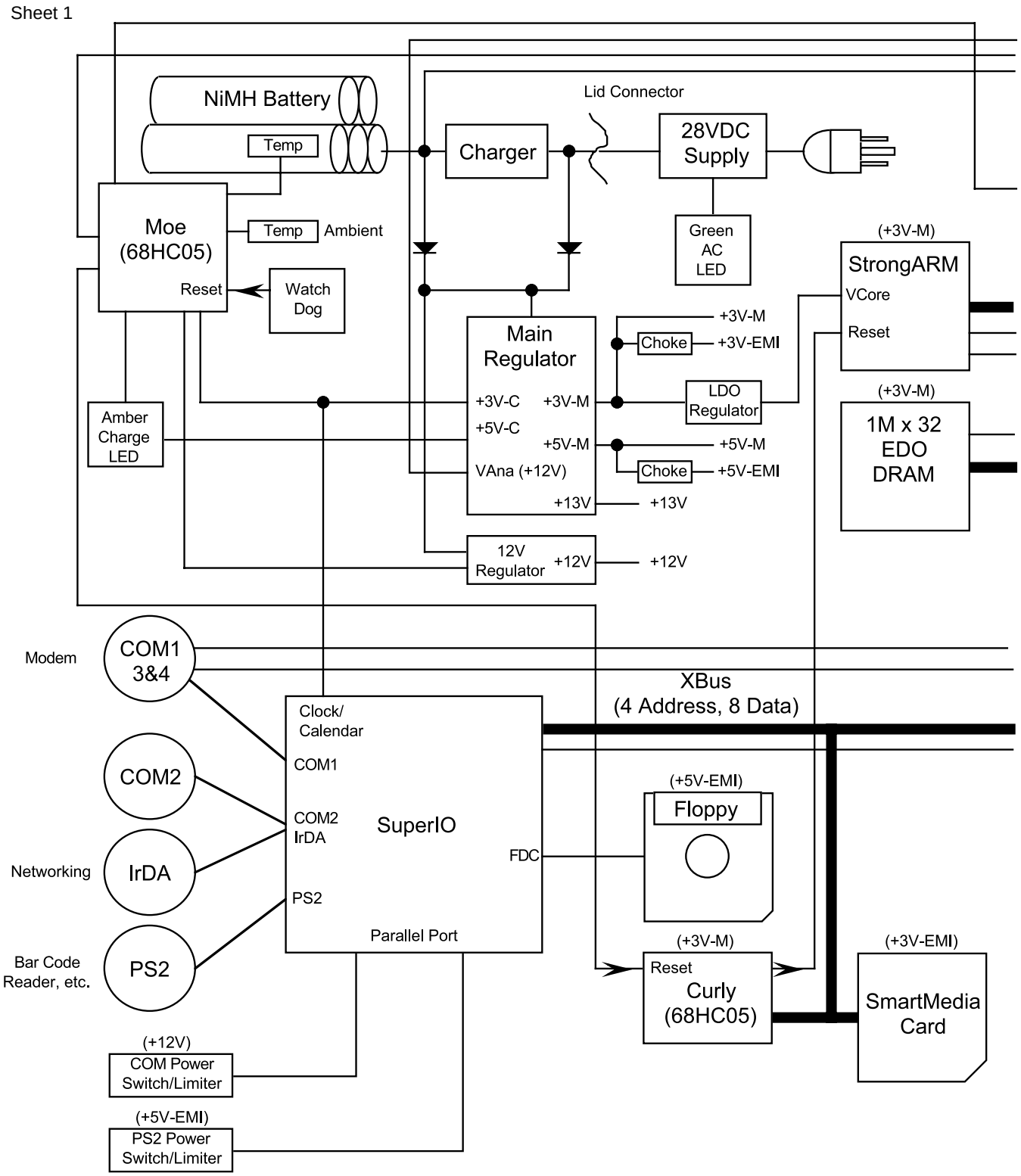
1. THE BARS SHOWN ON ALL POLARIZED CAPACITORS DENOTES THE POSITIVE TERMINAL.

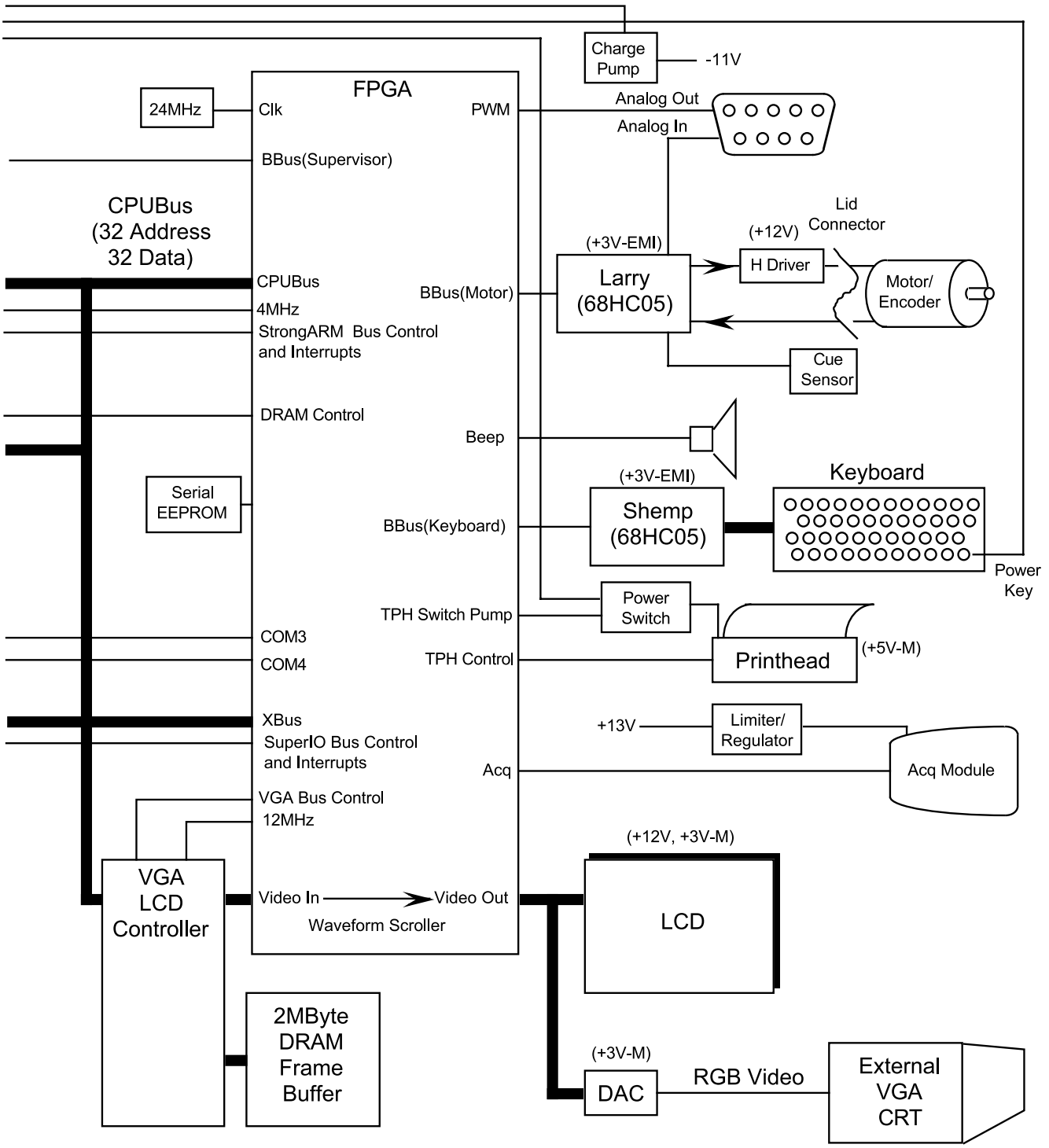
2. COMPONENTS R80, R126, R128, R163, R42, R27, TP1 - TP8 ARE NOT INSTALLED.

3. Y1, Y3 - 5, QP2 - 6 ARE NOT POLARIZED.

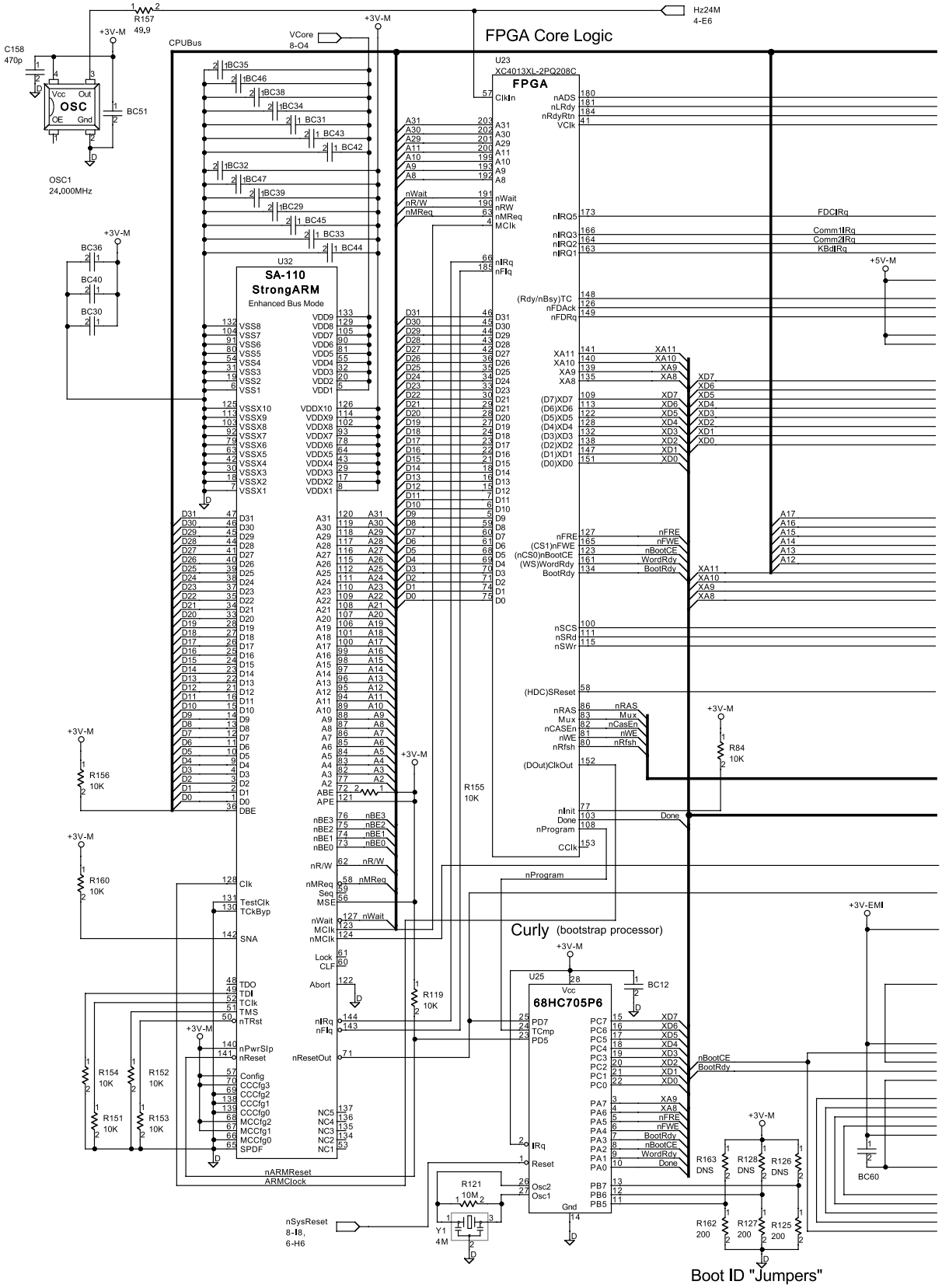


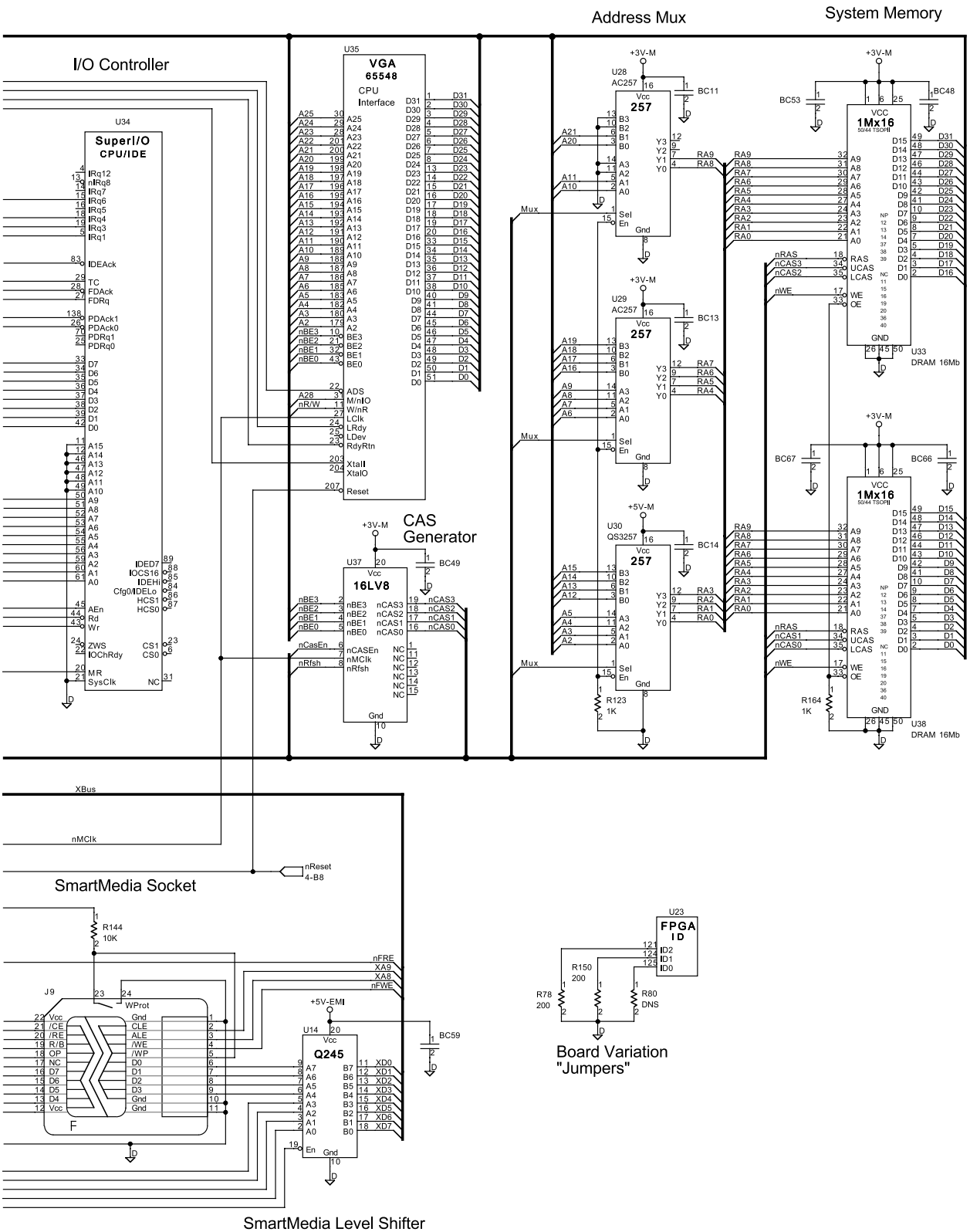
SD801212-003A CPU



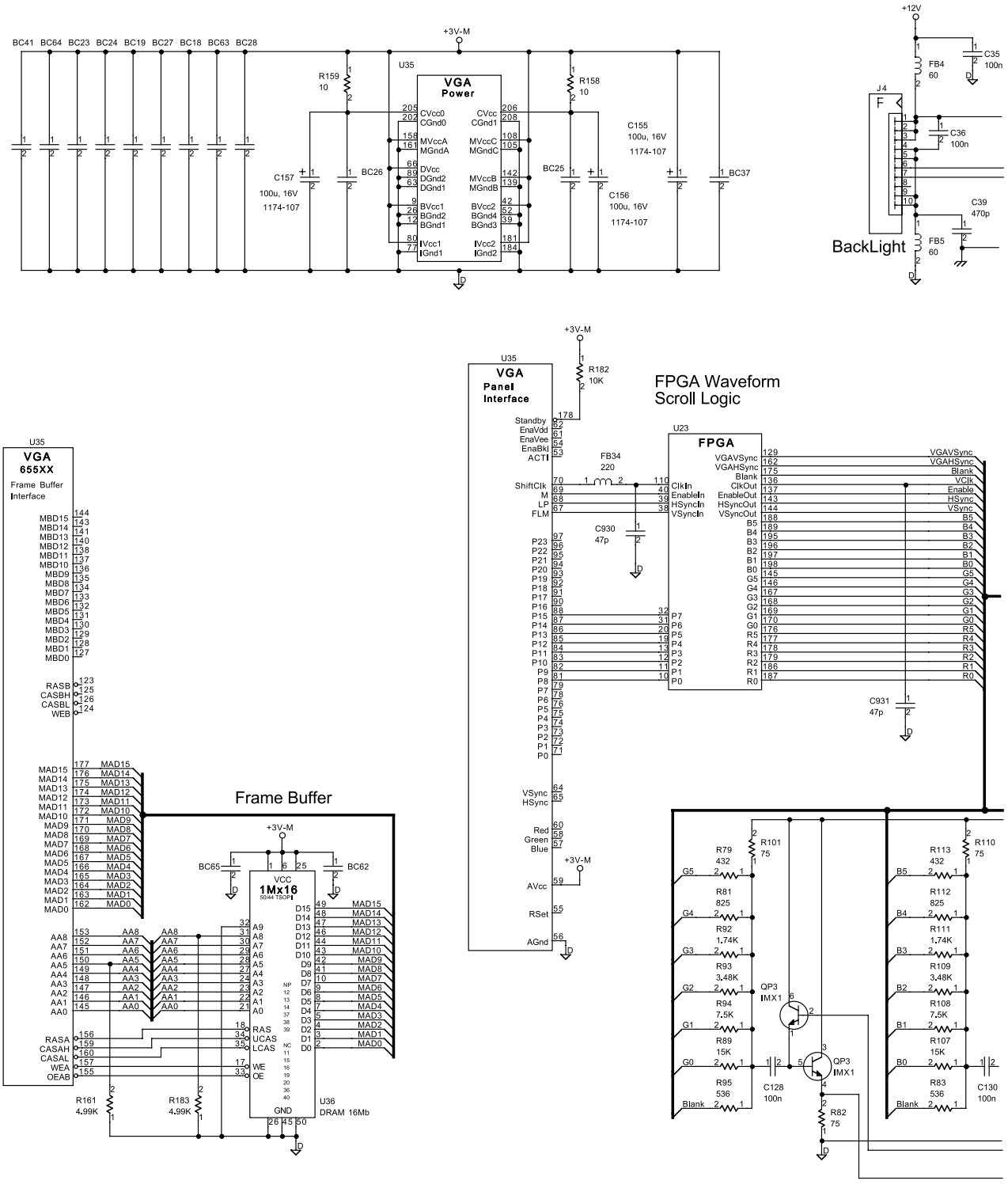

Charge Pump
-11V
FPGA
24MHz
Clk
PWM
Analog Out
Analog In
BBus(Supervisor)
CPUBus
(32 Address
32 Data)
Lid
Connector
(+12V)
(+3V-EMI)
CPUBus
BBus(Motor)
Larry
(68HC05)
H Driver
Motor/
Encoder
4MHz
StrongARM Bus Control
and Interrupts
Cue
Sensor
DRAM Control
Beep
Keyboard
(+3V-EMI)
Serial
EEPROM
BBus(Keyboard)
Shemp
(68HC05)
Power
Key
Power
Switch
TPH Switch Pump
COM3
COM4
TPH Control
Printhead
(+5V-M)
XBus
SuperIO Bus Control
and Interrupts
+13V
Limiter/
Regulator
Acq
Acq Module
VGA Bus Control
12MHz
(+12V, +3V-M)
VGA
LCD
Controller
Video In
Video Out
Waveform Scroller
LCD
2MByte
DRAM
Frame
Buffer
(+3V-M)
DAC
RGB Video
External
VGA
CRT

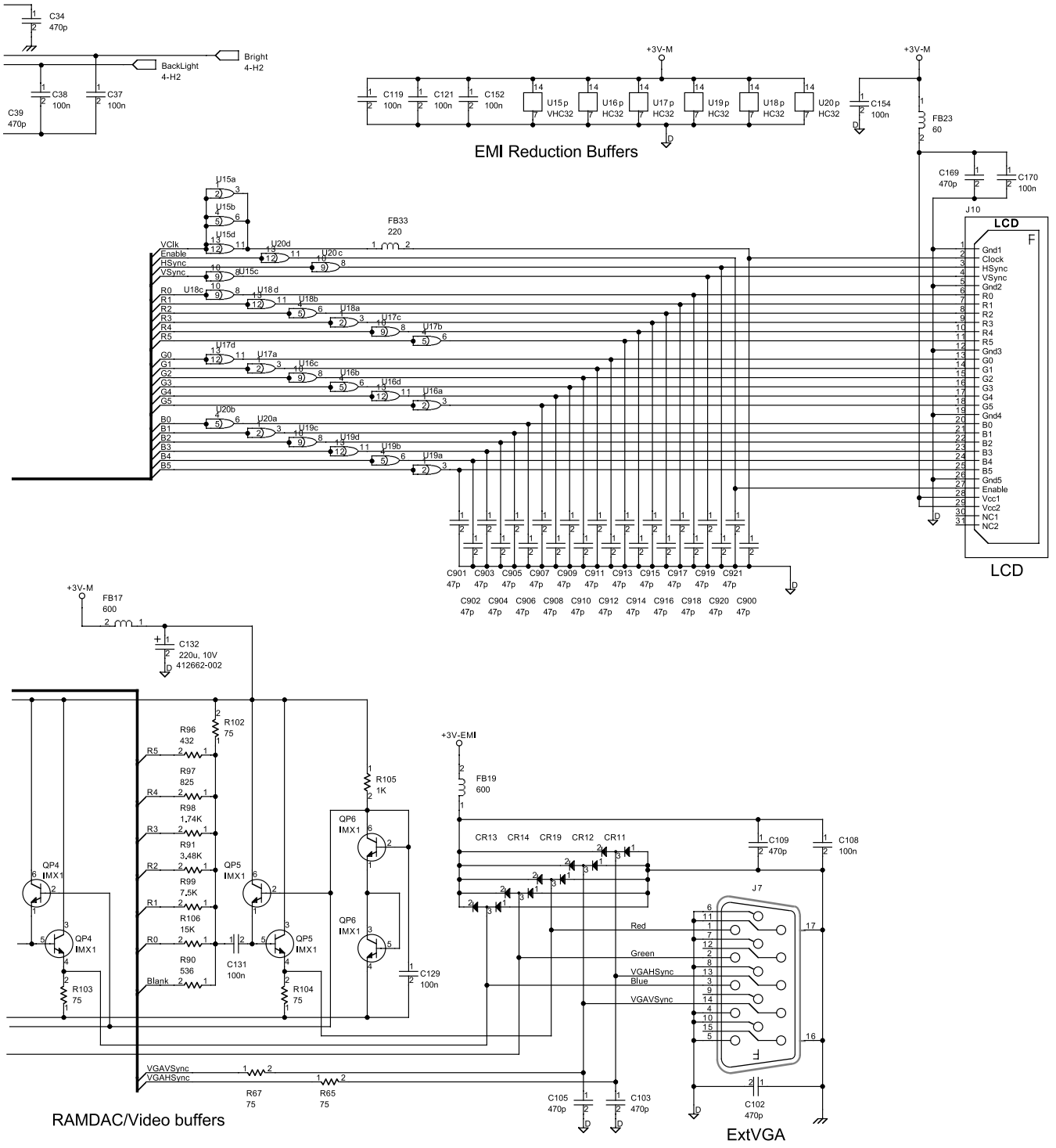
Sheet 2


FPGA Core Logic
SA-110
StrongARM
Enhanced Bus Mode
FPGA
XC4013XL-2PQ208C
Curly (bootstrap processor)
68HC705P6
OSC
OSC1
24.000MHz
R157
49.9
C158
470p
BC51
CPUBus
VCore
8-O4
Hz24M
4-E6
+3V-M
+5V-M
+3V-EMI
FDCIRq
Comm1IRq
Comm2IRq
KBdIRq
R155
10K
R156
10K
R160
10K
R119
10K
R84
10K
R154
10K
R152
10K
R151
10K
R153
10K
R121
10M
Y1
4M
R163
DNS
R128
DNS
R126
DNS
R162
200
R127
200
R125
200
BC60
Boot ID "Jumpers"
nProgram
nSysReset
8-I8,
6-H6
nARMReset
ARMClock

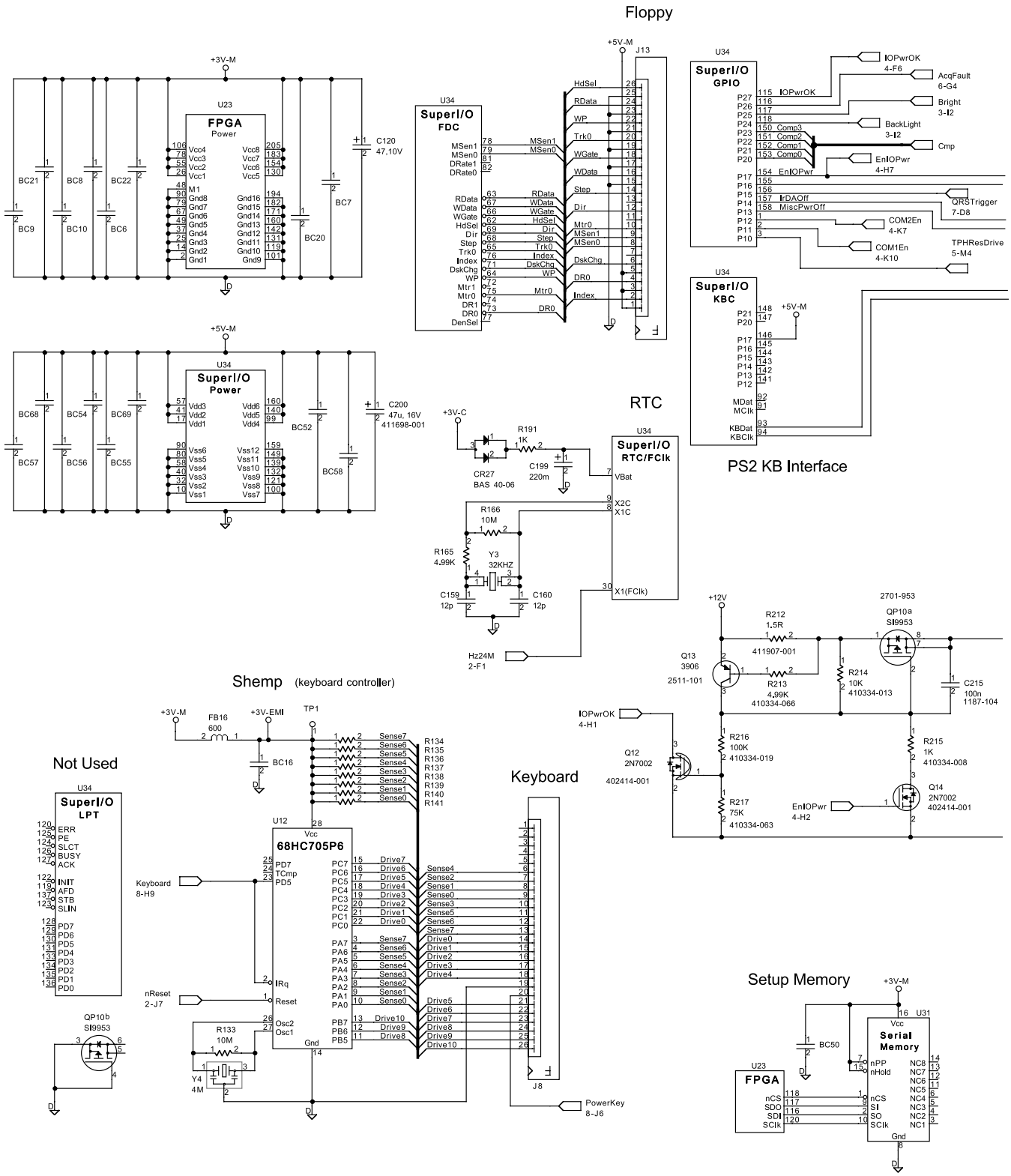

I/O Controller
Address Mux
System Memory
VGA
65548
CPU
Interface
SuperI/O
CPU/IDE
CAS
Generator
16LV8
Q245
257
AC257
QS3257
1Mx16
DRAM 16Mb
XBus
nMClk
nReset
4-B8
SmartMedia Socket
SmartMedia Level Shifter
FPGA
ID
Board Variation
"Jumpers"

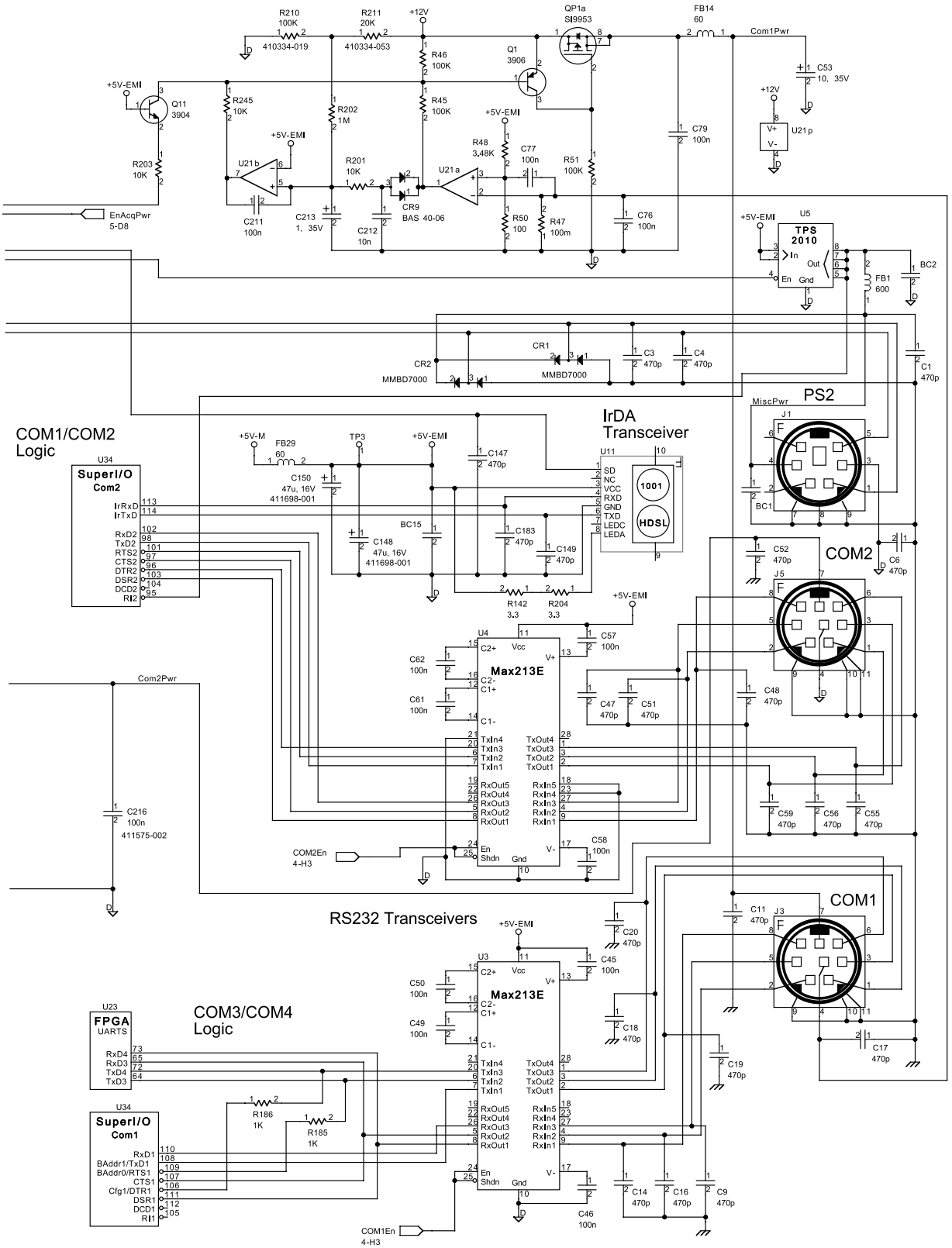
Sheet 3


VGA
Power
VGA
Panel
Interface
FPGA
FPGA Waveform
Scroll Logic
VGA
655XX
Frame Buffer
Interface
Frame Buffer
1Mx16
DRAM 16Mb
BackLight
+3V-M
+12V


EMI Reduction Buffers
LCD
RAMDAC/Video buffers
ExtVGA

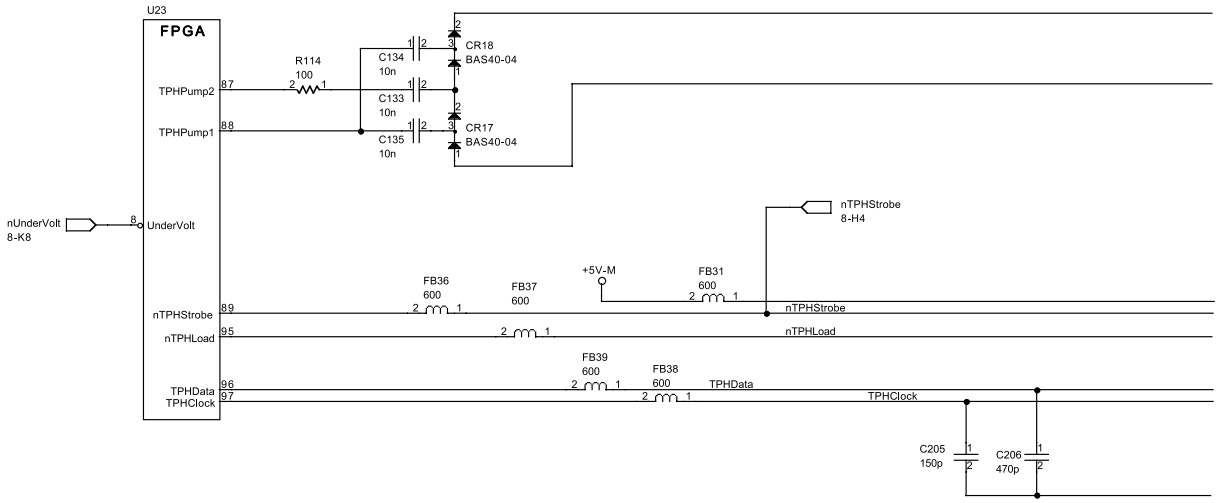
Sheet 4


Floppy
RTC
PS2 KB Interface
Shemp (keyboard controller)
Not Used
Keyboard
Setup Memory
U23
FPGA
Power
U34
SuperI/O
FDC
SuperI/O
GPIO
SuperI/O
KBC
SuperI/O
Power
SuperI/O
RTC/FClk
SuperI/O
LPT
U12
68HC705P6
U31
Serial
Memory
+3V-M
+5V-M
+5V-C
+12V
+3V-EMI
C120
47,10V
C200
47u, 16V
411698-001
C199
220m
R191
1K
CR27
BAS 40-06
R166
10M
R165
4.99K
Y3
32KHZ
C159
12p
C160
12p
Hz24M
2-F1
R212
1.5R
411907-001
R213
4.99K
410334-066
R214
10K
410334-013
C215
100n
1187-104
2701-953
QP10a
SI9953
Q13
3906
2511-101
Q12
2N7002
402414-001
R216
100K
410334-019
R217
75K
410334-063
R215
1K
410334-008
Q14
2N7002
402414-001
IOPwrOK
4-H1
EnIOPwr
4-H2
FB16
600
BC16
TP1
R134
R135
R136
R137
R138
R139
R140
R141
Sense7
Sense6
Sense5
Sense4
Sense3
Sense2
Sense1
Sense0
Keyboard
8-H9
nReset
2-J7
IRq
Reset
Osc2
Osc1
R133
10M
Y4
4M
Gnd
Vcc
PD7
TCmp
PD5
PC7
PC6
PC5
PC4
PC3
PC2
PC1
PC0
PA7
PA6
PA5
PA4
PA3
PA2
PA1
PA0
PB7
PB6
PB5
Drive7
Drive6
Drive5
Drive4
Drive3
Drive2
Drive1
Drive0
Drive10
Drive9
Drive8
J8
PowerKey
8-J6
QP10b
SI9953
BC50
nPP
nHold
nCS
SDI
SDO
SCIk
SI
SO
SCIk
NC8
NC7
NC6
NC5
NC4
NC3
NC2
NC1
IOPwrOK
4-F6
AcqFault
6-G4
Bright
3-I2
BackLight
3-I2
Cmp
EnIOPwr
4-H7
IrDAOff
MiscPwrOff
QRSTrigger
7-D8
COM2En
4-K7
COM1En
4-K10
TPHResDrive
5-M4
MSen1
MSen0
DRate1
DRate0
RData
WData
WGate
HdSel
Dir
Step
Trk0
Index
DskChg
WP
Mtr1
Mtr0
DR1
DR0
DenSel
MDat
MClk
KBDat
KBClk
VBat
X2C
X1C
X1(FClk)

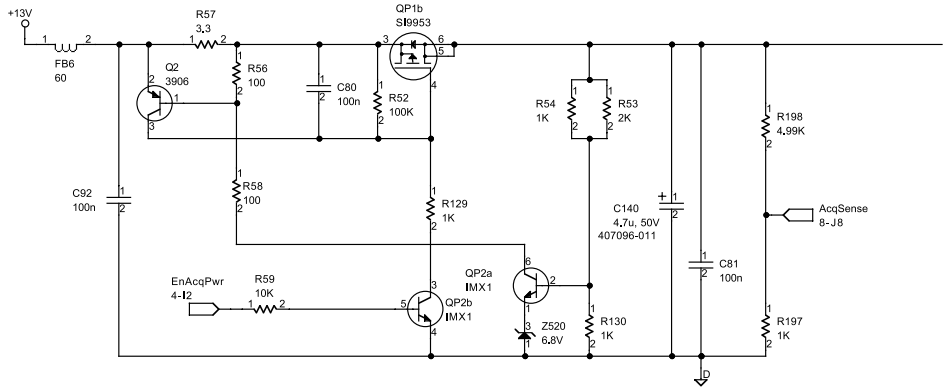

COM1/COM2
Logic
IrDA
Transceiver
PS2
COM2
COM1
RS232 Transceivers
COM3/COM4
Logic
Max213E
SuperI/O
Com2
SuperI/O
Com1
FPGA
UARTS
TPS
2010
1001
HDSL
MMBD7000
EnAcqPwr
5-D8
Com1Pwr
Com2Pwr
COM2En
4-H3
COM1En
4-H3
411575-002
411698-001
410334-019
410334-053
MiscPwr

Sheet 5

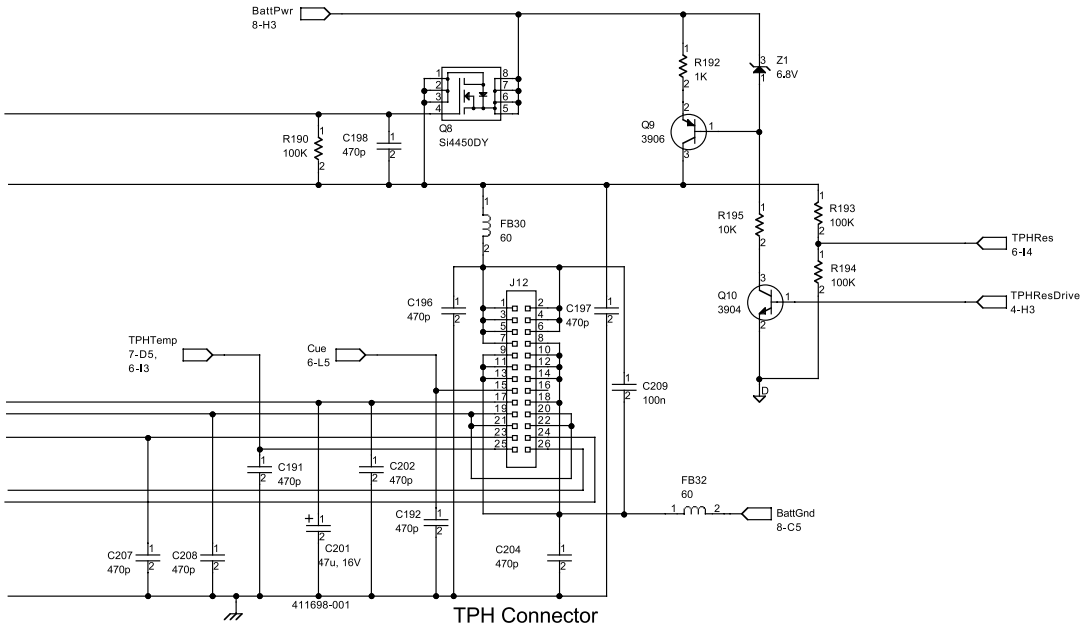
FPGA TPH Logic



Acquisition Power Switch

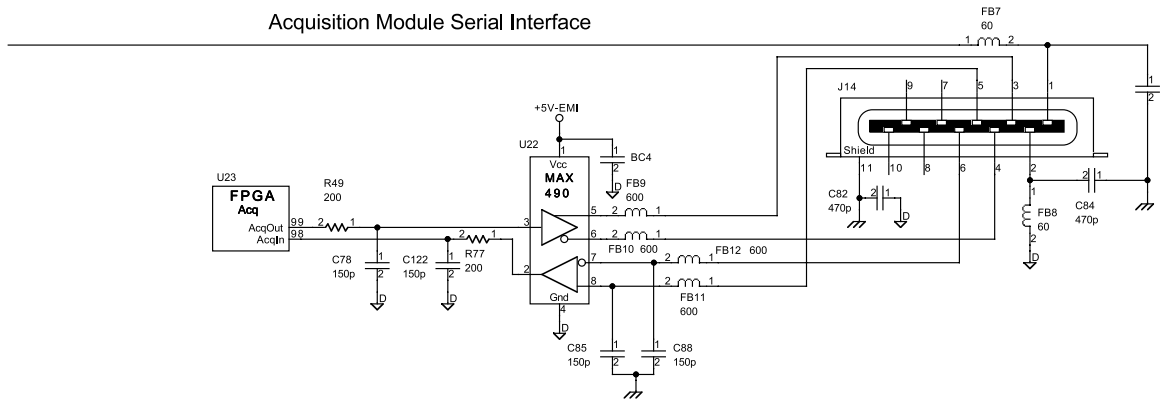


Thermal Printhead Interface

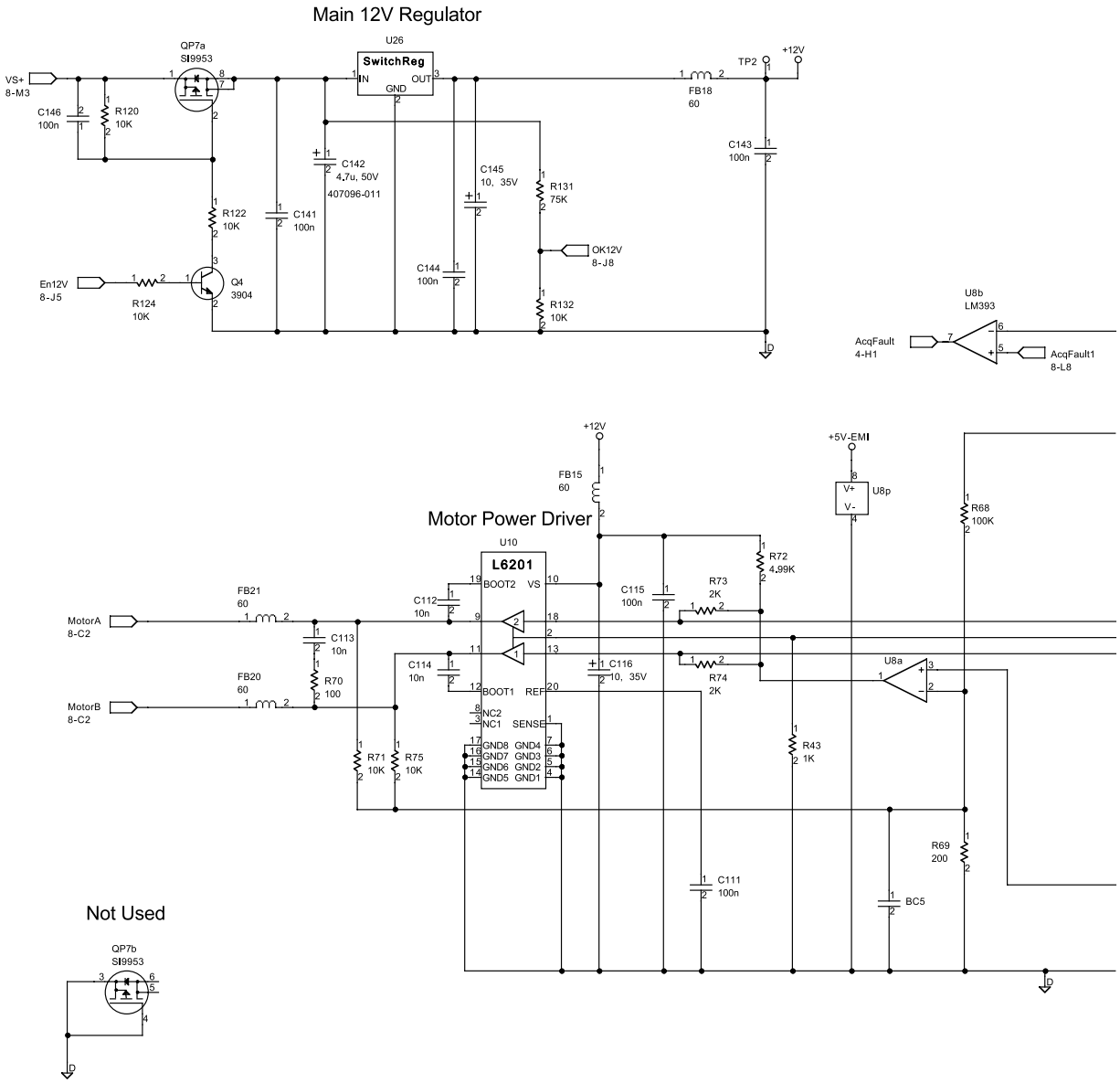


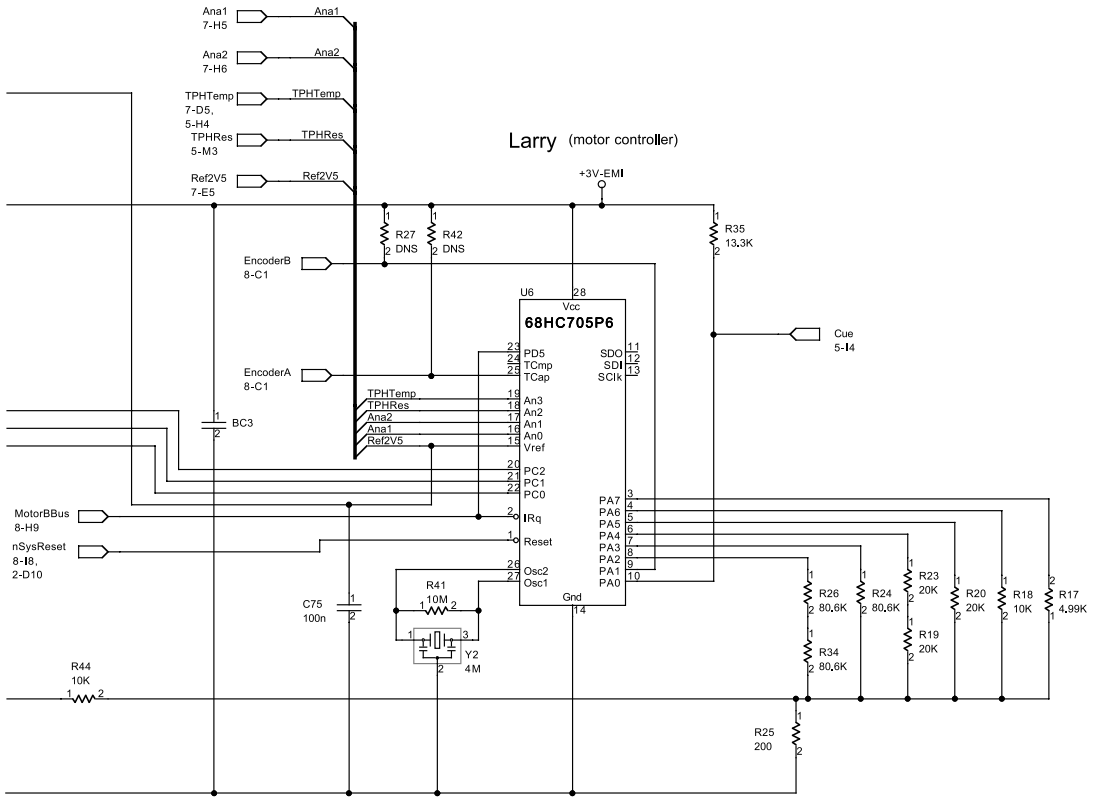
Acq Module Connector

Acquisition Module Serial Interface

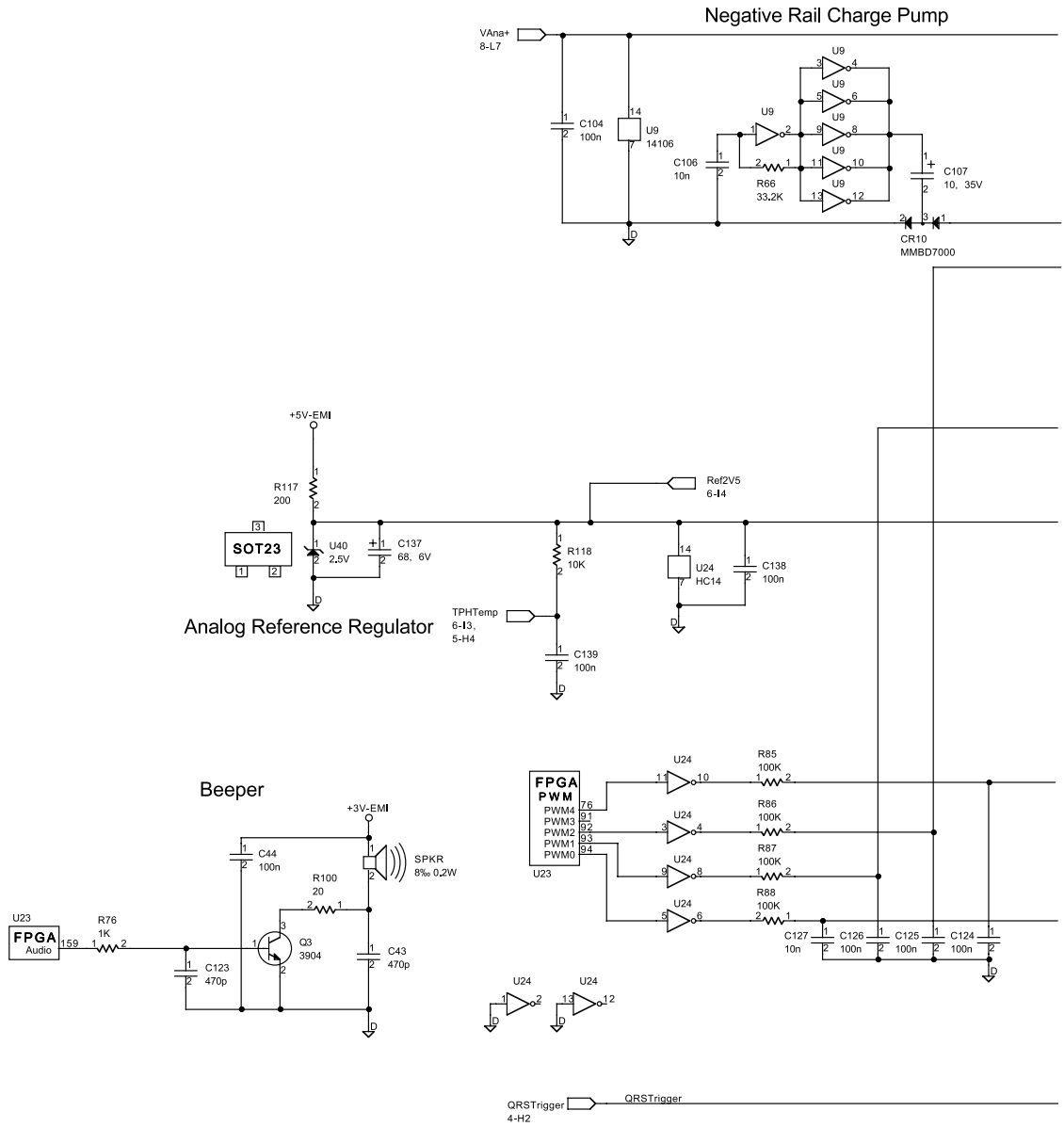


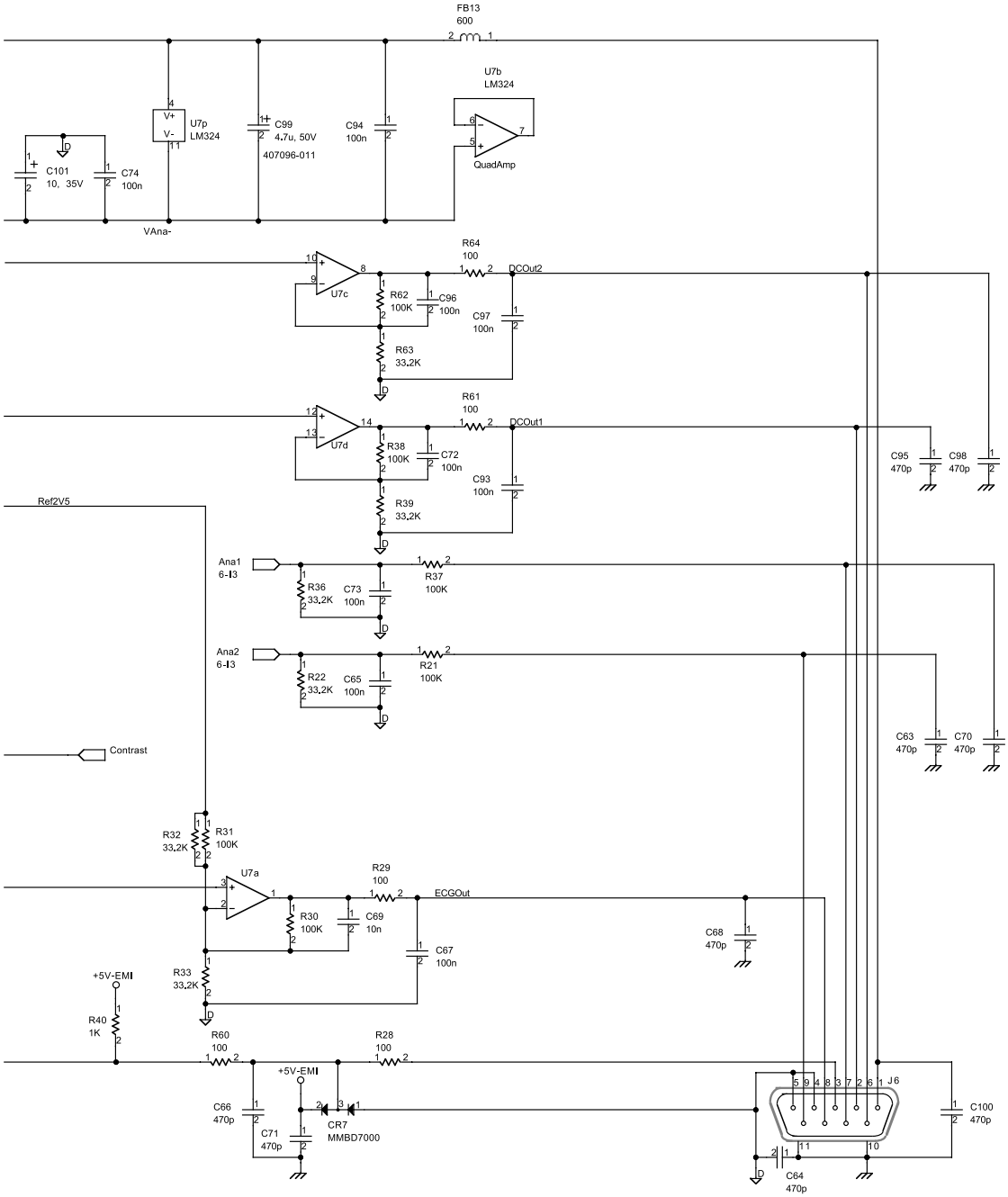
Sheet 6


Main 12V Regulator
QP7a
SI9953
U26
SwitchReg
IN
OUT
GND
VS+
8-M3
C146
100n
R120
10K
C142
4.7u, 50V
407096-011
C141
100n
R122
10K
C145
10, 35V
R131
75K
OK12V
8-J8
C144
100n
R132
10K
En12V
8-J5
R124
10K
Q4
3904
FB18
60
TP2
+12V
C143
100n
U8b
LM393
AcqFault
4-H1
AcqFault1
8-L8
Motor Power Driver
+12V
FB15
60
+5V-EMI
U8p
V+
V-
R68
100K
U10
L6201
BOOT2
VS
BOOT1
REF
NC2
NC1
SENSE
GND8
GND7
GND6
GND5
GND4
GND3
GND2
GND1
C112
10n
C113
10n
C114
10n
C115
100n
C116
10, 35V
R72
4.99K
R73
2K
R74
2K
R43
1K
R69
200
C111
100n
BC5
U8a
FB21
60
FB20
60
MotorA
8-C2
MotorB
8-C2
R70
100
R71
10K
R75
10K
Not Used
QP7b
SI9953


Larry (motor controller)
Ana1
7-H5
Ana2
7-H6
TPHTemp
7-D5,
5-H4
TPHRes
5-M3
Ref2V5
7-E5
+3V-EMI
R27
DNS
R42
DNS
R35
13.3K
EncoderB
8-C1
EncoderA
8-C1
U6
68HC705P6
Vcc
PD5
TCmp
TCap
SDO
SDI
SCIk
An3
An2
An1
An0
Vref
PC2
PC1
PC0
IRq
Reset
Osc2
Osc1
Gnd
PA7
PA6
PA5
PA4
PA3
PA2
PA1
PA0
Cue
5-I4
BC3
MotorBBus
8-H9
nSysReset
8-I8,
2-D10
C75
100n
R41
10M
Y2
4M
R44
10K
R26
80.6K
R24
80.6K
R23
20K
R20
20K
R18
10K
R17
4.99K
R34
80.6K
R19
20K
R25
200

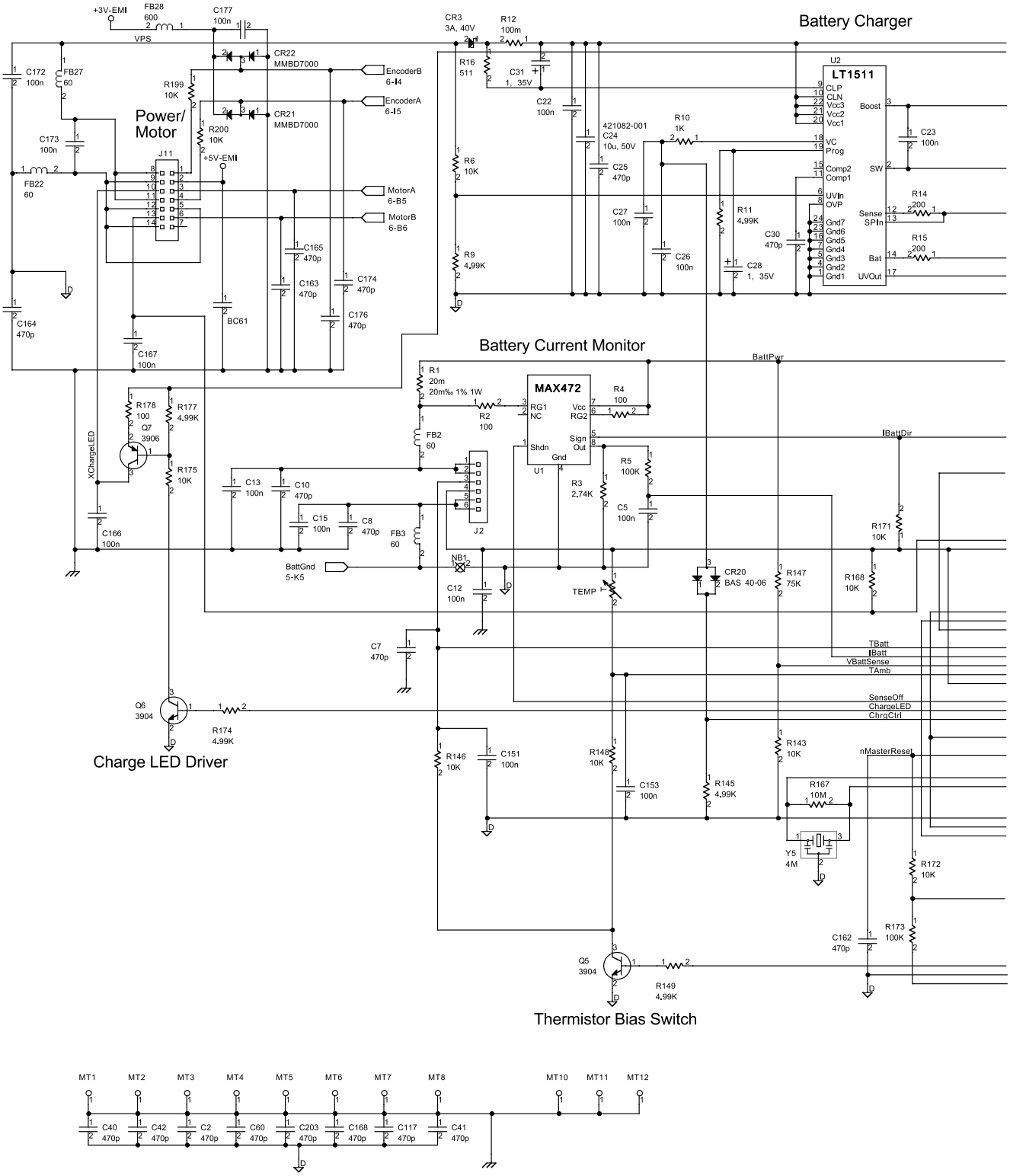
Sheet 7

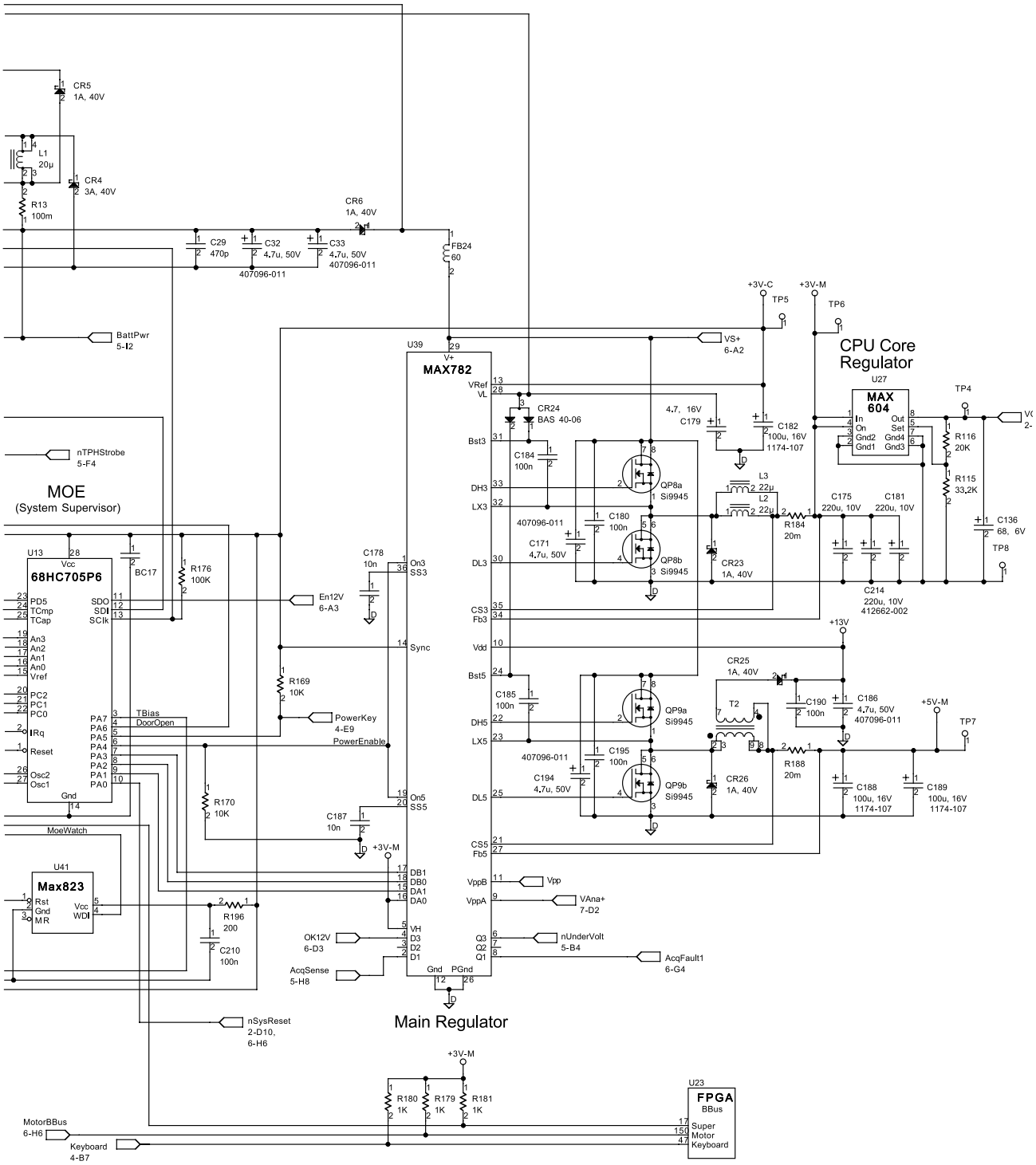

Negative Rail Charge Pump
VAna+
8-L7
C104
100n
U9
14106
C106
10n
R66
33.2K
C107
10, 35V
CR10
MMBD7000
+5V-EMI
R117
200
SOT23
U40
2.5V
C137
68, 6V
Analog Reference Regulator
Ref2V5
6-I4
R118
10K
U24
HC14
C138
100n
TPHTemp
6-I3,
5-H4
C139
100n
Beeper
+3V-EMI
C44
100n
SPKR
8‰ 0.2W
R100
20
U23
FPGA
Audio
R76
1K
Q3
3904
C123
470p
C43
470p
FPGA
PWM
PWM4
PWM3
PWM2
PWM1
PWM0
U23
R85
100K
R86
100K
R87
100K
R88
100K
C127
10n
C126
100n
C125
100n
C124
100n
QRSTrigger
4-H2
QRSTrigger



Analog I/O - QRS Trigger

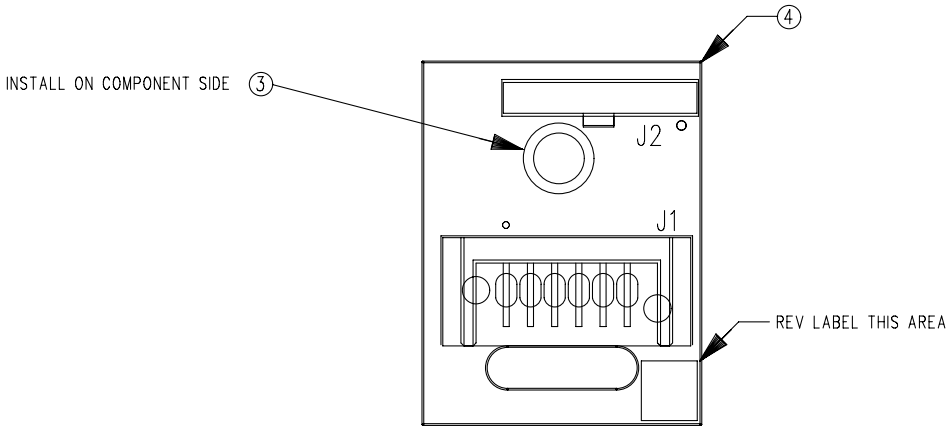
Sheet 8


Power/
Motor
Battery Charger
Battery Current Monitor
Charge LED Driver
Thermistor Bias Switch
LT1511
MAX472
+3V-EMI
+5V-EMI
VPS
BattPwr
IBattDir
TBatt
IBatt
VBattSense
TAmb
SenseOff
ChargeLED
ChrgCtrl
nMasterReset
XChargeLED
BattGnd
TEMP
EncoderB
6-I4
EncoderA
6-I5
MotorA
6-B5
MotorB
6-B6


CR5
1A, 40V
L1
20µ
CR4
3A, 40V
R13
100m
CR6
1A, 40V
C29
470p
C32
4.7u, 50V
C33
4.7u, 50V
407096-011
FB24
60
BattPwr
5-I2
+3V-C
+3V-M
TP5
TP6
VS+
6-A2
CPU Core
Regulator
U27
MAX
604
TP4
R116
20K
R115
33.2K
C136
68, 6V
TP8
nTPHStrobe
5-F4
MOE
(System Supervisor)
U13
68HC705P6
BC17
R176
100K
En12V
6-A3
U39
MAX782
V+
VRef
VL
CR24
BAS 40-06
4.7, 16V
C179
C182
100u, 16V
1174-107
Bst3
C184
100n
QP8a
Si9945
DH3
LX3
L3
22µ
L2
22µ
R184
20m
C175
220u, 10V
C181
220u, 10V
C180
100n
C171
4.7u, 50V
QP8b
Si9945
CR23
1A, 40V
C214
220u, 10V
412662-002
DL3
CS3
Fb3
C178
10n
On3
SS3
Sync
Vdd
+13V
CR25
1A, 40V
Bst5
C185
100n
QP9a
Si9945
T2
C190
100n
C186
4.7u, 50V
407096-011
+5V-M
TP7
DH5
LX5
C195
100n
C194
4.7u, 50V
QP9b
Si9945
CR26
1A, 40V
R188
20m
C188
100u, 16V
1174-107
C189
100u, 16V
1174-107
DL5
CS5
Fb5
R169
10K
PowerKey
4-E9
PowerEnable
TBias
DoorOpen
R170
10K
C187
10n
On5
SS5
MoeWatch
U41
Max823
R196
200
C210
100n
DB1
DB0
DA1
DA0
VppB
Vpp
VppA
VAna+
7-D2
VH
D3
D2
D1
OK12V
6-D3
AcqSense
5-H8
Q3
Q2
Q1
nUnderVolt
5-B4
AcqFault1
6-G4
Gnd
PGnd
Main Regulator
nSysReset
2-D10,
6-H6
+3V-M
R180
1K
R179
1K
R181
1K
U23
FPGA
BBus
Super
Motor
Keyboard
MotorBBus
6-H6
Keyboard
4-B7

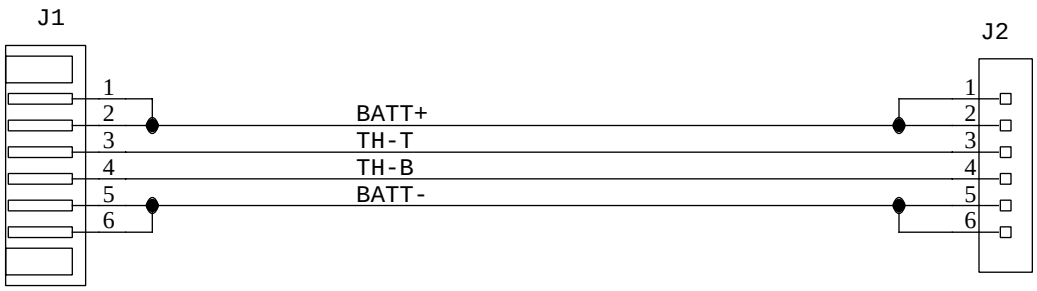
801220-001B Battery Transition PCB

Find Num	Item Number	Item Description	Qty
1	418088-001	CONN HDR MULTI-DIRECT 6 POS	1
2	421039-001	FLEXPAC CABLE 6 POSITION 3”L	1
3	421490-001	INSERT NUT PCB M3X.5 KF2M3	1
4	801221-001	CKT BD MAC 5000 BATTERY TRANS	1
5	SD801220-001	SCHEM MAC 5000 BATTERY TRANS	0



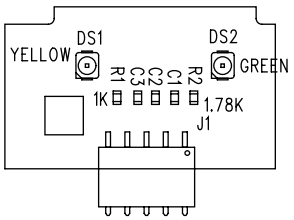
COMPONENT SIDE VIEW

SD801220-001A Battery Transition



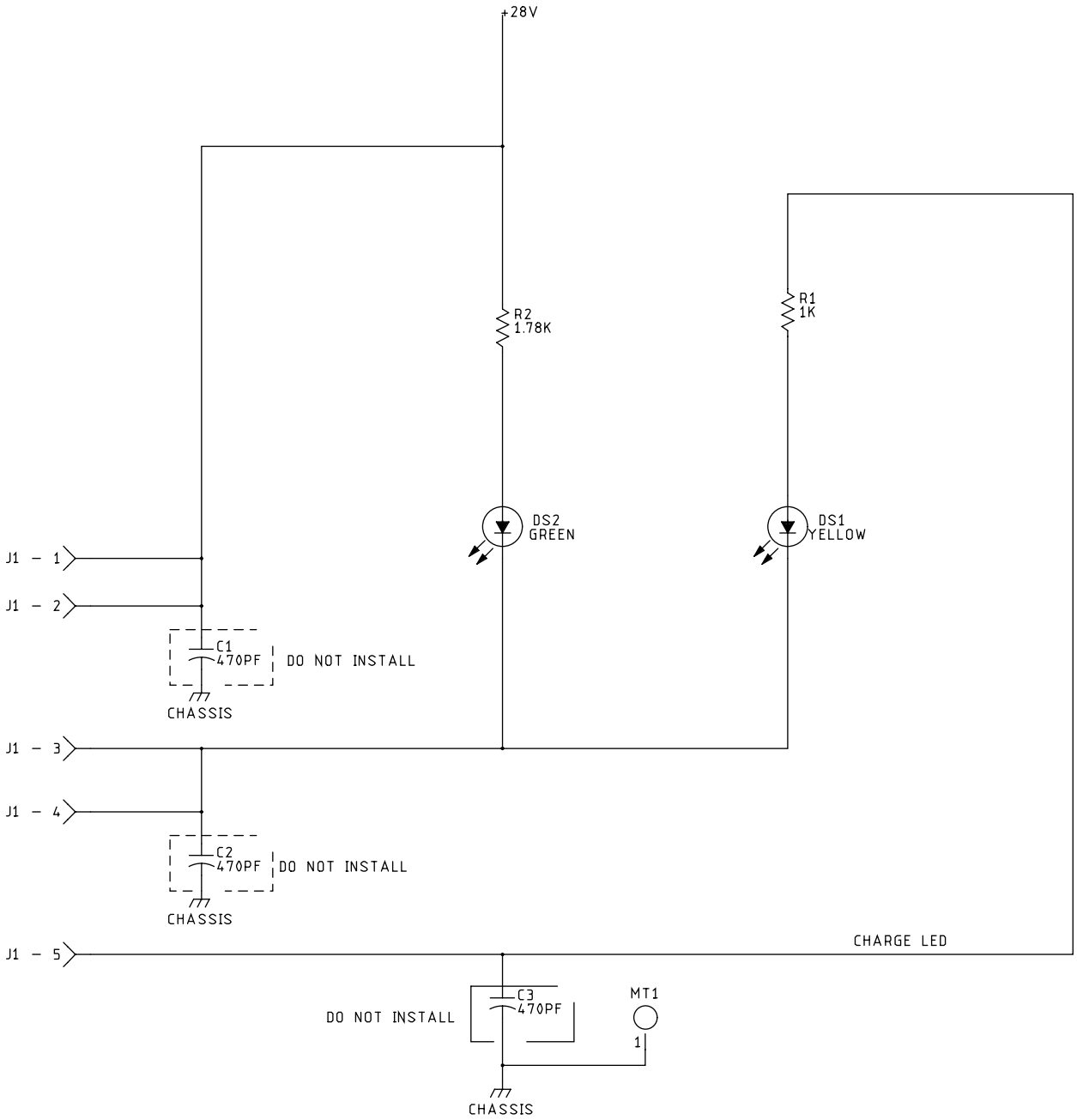
801222-001A LED PCB

Find Num	Item Number	Item Description	Ref Des	Qty
1	410334-008	RES SM CER 0603 1K 1% 1/16W	R1	1
2	410334-250	RES SM 0603 1.78K 1% 1/16W	R2	1
4	411843-002	CONN FRICTION LK RA .1CTR 5P		1
5	421205-001	LED YELLOW HYPER-BRIGHT TOPLED	DS1	1
6	421205-002	LED PURE GREEN TOPLED LAMP	DS2	1
7	801223-001	CKT BD LED MAC 5000		1
8	SD801222-001	SCHEM LED BOARD MAC 5000		0



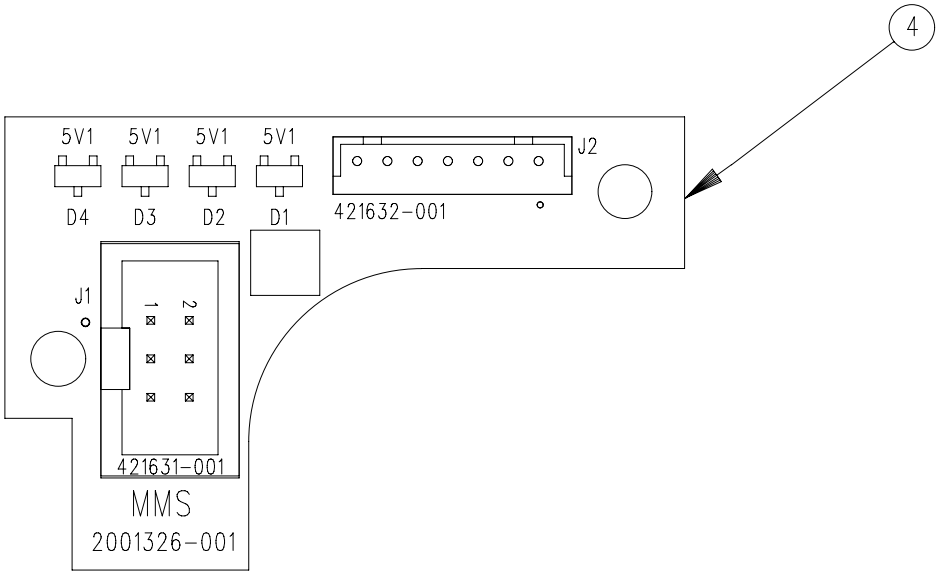
Note: C1, C2, C3 are not installed.

SD801222-001A LED

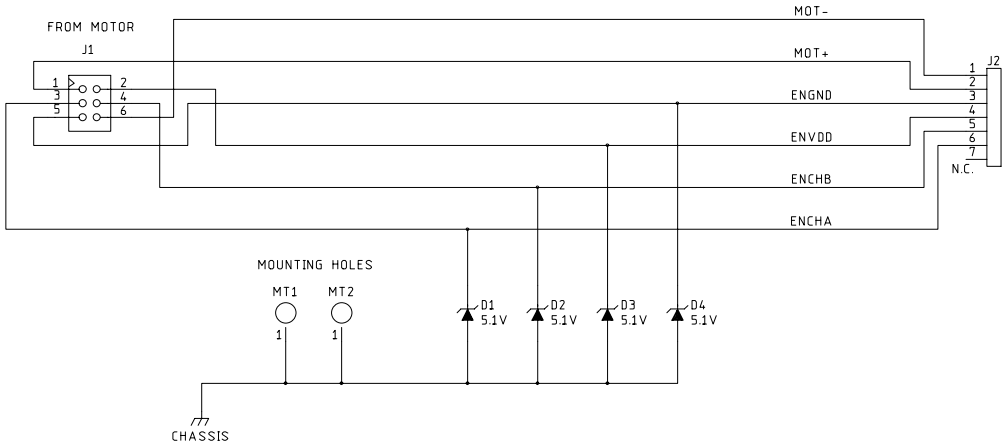


2001326-001A Motor Protect PCB

Find Num	Item Number	Item Description	Ref Des	Qty
1	406918-001	DIODE ZENER SM 5V1	D1,D2,D3,D4	4
2	421631-001	CONN HDR RBN VERT 2 X 3M	J1	1
3	421632-001	CONN HDR VERT 7 POS	J2	1
4	2001325-001	CKT BD MAC 5000 MOTOR PROTECT		1
5	2001327-001	SCHEM MAC 5000 MOTOR PROTECT		0



2001327-001A Motor Protect



Appendix A: Abbreviations

Standard Abbreviations **3**

Standard Abbreviations

A

A	ampere
A-ang	antianginal
A-arh	antiarrhythmic
A-coa	anticoagulants
A-hyp	antihypertensive
A1 - A4	auxiliary leadwires
AAMI	American Association of Medical Instrumentation
ABP	ambulatory blood pressure
ac, AC	alternating current
ACLS	Advanced Cardiac Life Support
A/D	analog-to-digital
Adj	adjustable
AG	automotive glass
Ah	ampere hours
AHA	American Heart Association
Al	aluminum
AllRam	all RAM
AllSec	all sector
AllTrk	all track
ALT	alternate
Alt-Off	alternate offset
am, AM	acquisition module, ante meridiem
AM-1	acquisition module-1
AM-1M	acquisition module-1 modified
AM-2	acquisition module-2
AM-3	acquisition module-3
AM-4	acquisition module-4
amp	ampere
Ampl	amplifier
AMU	ambulatory monitoring unit
ANA	analog
ANLG	analog
AnsrTone	answer tone
A/O	Analog Output
ASCII	American Standard Code for Information Interchange
ASSY	assembly
Attn	attention
AUG	August
AUST	Australian
AUSTRALN	Australian
Auto	automatic
AutoRhym	automatic rhythm
AUX	auxiliary
aVF	augmented left leg lead
avg	average
aVL	augmented left arm lead
aVR	augmented right arm lead
AWG	American Wire Gage

B

Bd	board, baud
BDGH	binding head
BetaB	beta blockers
BKSP	backspace
BLK	black
BLU	blue
Blvd	boulevard
BP	blood pressure
BPM	beats per minute
BRIT	Britain
BRN	brown
BSI	British Standards Institute
Btu	British thermal unit

C

CalcBlk	calcium blockers
CAPOC	Computer Assisted Practice of Cardiology
CASE	Computer Aided System for Exercise
Catoprl	Catopril
Cauc	Caucasian
Cer	ceramic
CFM	cubic feet/minute
CGR	computer graphic record
Ch, CH	channel
C/L	center line
CLK	clock signal
Clonid	Clonidine
cm	centimeter
cm^2	square centimeters
Cmd	command number
CMMR	common mode rejection ratio
CMOS	complementary metal-oxide semiconductor
c/o	in care of
COM1	communications port 1
COM2	communications port 2
ComLink	communications link
Comp	composition
Confrmd	confirmed
Cont, CONT	Continental, continued
Coumadn	Coumadin
CPR	cardiopulmonary resuscitation
CPU	central processing unit
CR	diode

CRC	cyclic redundancy check
CRD	cord
crt, CRT	cathode ray tube
CSA	Canadian Standards Association
CTRL	control

D

D/A	digital to analog
DA	damping relay
dac, DAC	digital-to-analog converter
DAN	Danish
Dat/Tim	date/time
dBm	decibel (referenced to 1 milliwatt into 600 ohms)
dc, DC	direct current
DD	double density, day
DDD	Digital Diagnostic Diskette
DEC	Digital Equipment Corporation, December
Del	delete
DEMO	demonstration
DES	designation
DevId	device identification
Diag	diagnostic
Digital	Digitalis
Digitox	Digitoxin
Digox	digoxin
Digoxin	Digoxin-Lanoxin
DIP	dual in-line package
Dirctry	directory
Diurt	diuretics
DOB	date of birth
DOS	disk operating system
DP	diametral pitch
DPST	double-pole, single-throw
DRAM	dynamic RAM
DR/DT	digital recording/digital transmission
DSKTP	desktop
Dysopyr	Dysopyramide

E

E	enable, vector electrode site, vector lead
ecg, Ecg, ECG	electrocardiogram
ECO	Engineering Change Order
EDIC	Electrocardiograph Digital Information Center
EEPROM	electrically erasable programmable ROM
e.g.	for example
EGA	enhanced graphics adapter
EMF	electromotive force
EMI	electromagnetic interference
ENG	English
EOF	end of file
EPIC	Electronic Patient Information Chart
EPLD	electrically programmable logic device
EPROM	eraseable, programmable, read-only memory
ESD	electrostatic discharge
etc, etc.	et cetera
EURO	Europe, European
EXP	Expanded

F

F	fuse, Farad, female
F1-F5	function keys 1 through 5
Fax	facsimile
FCC	Federal Communications Commission
FE	front end
FILH	fillister head
FLH	flat head
FLRAM	flash RAM
FR	French
FrntEnd	front end
FSK	frequency shift keying
ft	foot, feet
Furosem	Furosemide

G

g	gram, acceleration due to gravity
GB	Great Britain
GERM	German, Germany
GND	ground, digital ground (dc common)
GRN	green
GRY	gray

H

H	high, vector electrode site, vector lead
HDLC	high-level data link control
Hex, HEX	hexagon, hexadecimal
HH	hour
HiRes	high-resolution
Hr	hour
Hydral	Hydralazine
Hz	Hertz (cycles per second)

I

I	on, input, vector electrode site
I, II, III	limb leads
IC	integrated circuit
ID	identification
i.e.	that is
IEC	International Electrotechnical Commission
in	inch
IN	input
inc, inc., INC	incorporated
Info	information
Ins	insert

I/O	input/output
I/P	input
ISA	industry standard architecture
Isosorb	Isosorbide
IT	Italian, Italy

J

JAN	January
JIS	Japan Industrial Standards

K

k, K	kilo, 1000, 1024
Kb, KB	kilobyte
kg, Kg	kilogram
kHz, KHz	kilohertz
kV, KV	kilovolt
Kyb	keyboard

L

L	line
L1	level one
L2	level two
LA	left arm
lb	pound
LCD	liquid crystal display
Lcl Line	local line
Ld Grps	lead groups
LED	light-emitting diode
LH	left hand
Lidoca	Lidocaine
LL	left leg
Loc	location
LocPc	Local MAC PC
LogRetry	log retry
Ltd	limited

M

m	meter
M	megabyte, metric, vector electrode site, vector lead, male
mA	milliamperes
MAC	Microcomputer Augmented Cardiograph
mains voltage	voltage of a supply mains between 2 line conductors of a polyphase system or voltage between the line conductor and the neutral of a single-phase system
max	maximum
Measure	measurements
Med	medications
MEM	memory
MF	metal film
MHz	megahertz
min	minutes, minimum
Misc	miscellaneous
mm	millimeter
MM	minute
MMM	month
mm/mV	millimeter per millivolt
mm/s	millimeter per second
MMS	Marquette Medical Systems
Modem	modulator/demodulator
MOS	metal oxide semiconductor
MPE	metallized polycarbonate expitaxial
ms	milliseconds
MS-DOS	Microsoft Disk Operating System
MTBF	mean time between failures
mtg	mounting
MTR	MOTOR
MUSE	Marquette Universal System for Electrocardiography
mux	multiplexer
mV	millivolt
mVR	minus (inverted) aVR

N

N	neutral
n/a	not available
NA	not applicable
NC	no connection
Nitrate	nitrates
NLQ	near letter quality
NMI	non-maskable interrupt
NMOS	N-channel metal-oxide semiconductor
No	number
NO	normally open
norm	normal
nS	nanoseconds
NSR	Normal Sinus Rhythm

O

O	off, original
OE	other errors
OEM	original equipment manufacturer
OH	off-hook relay
OneSec	one sector
ORG	orange
Orig	original
OUT	output
oz	ounce

P

P	P wave (section of the ECG waveform)
p-p	peak-to-peak
PA	P wave amplitude
Params	parameters
Passwds	passwords

PatData	patient data
PatInfo	patient information
PATN	patient
PC	printed circuit, personal computer
PCB	printed circuit board
pF	picofarad
Pgm	program
PgmId	program identification
Phenoth	Phenothiazide
Phenytn	Phenytoin
PID	patient identification digit
PLCC	plastic leadless chip carrier
PM	power module
pm, PM	post meridiem, preventive maintenance
PM-2	Power Module-2
PM-3	Power Module-3
pn, PN	part number
PNH	pan head
PPA	P wave amplitude
PR	ECG signal interval
Pro-Off	progressive offset
Procain	Procainamide
PROM	programmable read-only memory
Propran	Propranolol
PSK	phase shift keying
PSU	power supply unit
Psych	psychotropic
PUP	pull-up signal
PVC	polyvinyl chloride
PWM	pulse-width modulation
PWR	power
PWR CRD	power cord

Q

Q	transistor
QA	quality assurance, Q wave amplitude
QAD	Quality Assurance Deviation
QAM	quadrature amplitude modulation (phase and amplitude modulation)
QC	quality control
QD	Q wave duration
QRS	QRS complex (portion of ECG waveform), interval of ventricular depolarization
QT	QRS interval
QTC	QRS interval
QTY	quantity
Quinid	Quinidine

R

R	resistor, red, reset
RA	right angle, right arm or R wave amplitude
RAM	random access memory
RC	resistor capacitor
RD	R wave duration
Ref	reference, refresh
REN	Ringer Equivalence Number
Reserp	Reserpine
REV	revision
RevdBy	reviewed by
RevXmit	reverse transmission
rf	radio frequency
RFI	radio frequency interference
RGB	red, green, blue
RI	ring indicate
RL	right leg
RMR	Rhythm and Morphology Report
ROM	read only memory
RPA	R wave amplitude
RPD	R wave duration
rpt, Rpt	report
RTC	real time clock
RTI	relative to patient input
RTN	return
RVS	reverse
R/W	read/write

S

12SL	12 simultaneous leads
s, S	second, select, switch
SA	s wave amplitude
SB	slow-blow
SCL	safe current limits
SD	schematic diagram, S wave duration
SE	serial input/output errors
sec	second
sec.s	seconds
SEER	Solid-state Electronic ECG Recorder
SING	Singapore
SP	Spanish
SPA	S wave amplitude
SPDT	single-pole, double-throw
SRAM	static RAM
ST-T	ST-T wave (section of the ECG waveform)
standrd, Standrd	standard
STD	standard
STE	ST segment displacement at the end
STJ	ST segment displacement at the J point
STM	ST segment displacement at the mid-point between STJ and STE
stmts, Stmts	statements
supply mains	permanently installed power source
SVT	power cord type; 300 V
sw, SW	switch, software
SW	Swedish, Sweden

T

T Tone	touch tone
TA	T wave amplitude
Tant	tantalum
TDML	treadmill
TE	timeout errors
Tech	technical
Thiazid	Thiazide
TM	trademark
Tot	total
TP	test point
TPA	T' wave amplitude
TRAM	Transport Remote Acquisition Monitor
Tricyli	Tricylic antidepressant
TTL	transistor-transistor logic, TTL levels
TVS	transient voltage suppressor

U

UE	undefined errors
uF	microfarad
UL	Underwriters' Laboratory, Inc
Unconf	unconfirmed
UUT	unit-under-test

V

v, V	volt, volts
V1-V6	precordial leads
V123	V1, V2, V3
V3R	precordial lead
V456	V4, V5, V6
V4R	precordial lead
V ac	volts, alternating current
V dc	voltage, direct current
VA	volt-amperes
Var	variable
VDE	Verband Deutscher Elektrotechniker (German regulatory agency)
Vent.	ventricular
VF	ventricular fibrillation
VGA	video graphics array
VIA	versatile interface adapter
VIO	violet
Volt	voltage
VRAM	video RAM
vs	versus

W

w/	with
W	watt
Warfar	Warfarin
WHT	white
WI	Wisconsin

X

x	by (as in "8-1/2 x 11")
XCV	transceiver
X,Y,Z	orthogonal leads

Y

Y	year, yellow
yr	year
yrs	years
YY	year

Symbols

↑	SHIFTed or alternate function
µ	micro
µF	microfarad
µs, µsec	microsecond
68K	68000
&	and
#	number
°C	degrees Celsius
°F	degrees Fahrenheit
Ω	Ohm, ohm
%	percent
®	registered
>	greater than
<	less than
±	plus or minus
*	An asterisk after a signal name indicates the signal is active at its relatively lower potential, or "active-low." Signals without the asterisk suffix are active at their relatively higher potential, or "active-high."
12SL	12 simultaneous leads

Appendix B: Technical Specifications

Technical Specifications **3**

Technical Specifications

Table B-1. Computerized Electrocardiograph	
Item	**Description**
Instrument Type	15 lead (14 channel) microprocessor-augmented, automatic electrocardiograph
Analysis Frequency	500 samples/s (sps)
ECG Storage	150 ECG's (typical), 200 (maximum) on removable media (1.44 MB, 3.5" diskette)
Digital Sampling Rate	4000 samples/s/channel
Analysis	Pediatric and vectorcardiography Optional: 12SL analysis, HI-RES and PHI-RES late potential analysis
Pre-acquisition	Provides 10 s of instantaneous ECG acquisition
Dynamic Range	AC differential: ±5 mV DC offset: ±320 mV
Resolution	4.88 µV/LSB @ 250 sps, 1.22 µV/LSB @ 500 sps
Frequency Response	–3 dB @ 0.01 to 150 Hz
Common Mode Rejection	>140 dB (123 dB with AC filter disabled)
Input Impedance	>10 MΩ @ 10Hz, defibrillator protected
Patient Leakage Current	<10 µA
Pace Detection	750 µV @ 50 µs duration, Orthogonal LA, LL and V6
Special Acquisition Functions	Disconnected lead detection, electrode impedance
Communication	MAC and MUSE system compatible RS-232 Optional: Modem and FAX transmission, remote retreival (remote query)

Table B-2. Display	
Item	**Description**
Type	264mm (10.4 in.) diagonal graphics backlit AM LCD
Resolution	640 x 480 pixels, with waveform enhancement
Displayed Data	Heart rate, patient name, ID, clock, waveforms, lead labels, speed, gain and filter settings, warning messages, prompts and help messages

Table B-3. Writer	
Item	**Description**
Type	Thermal dot array
Speeds	5, 12.5, 25, 50 mm/s (same as display)
Number of Traces	3, 6, 12, or 15 user-selectable (same as display)
Sensitivity/Gain	2.5, 5, 10, 20, 10/5 (split calibration) mm/mV (same as display)
Speed Accuracy	± 2%
Amplitude Accuracy	± 5%
Resolution	Horizontal 1000 dpi @ 25 mm/s, 200 dpi vertical
Paper Type/Size	Thermal z-fold, perforated, 215.9 mm x 276.4 mm (8.5 in. x 11 in.) fanfold, 300 sheets per pack

Table B-4. Keyboard	
Item	**Description**
Type	Sealed elastomer with soft function keys, alphanumeric keys, writer controls and TrimPad cursor controls

Table B-5. Electrical	
Item	**Description**
Power Supply	AC or battery operation
AC Input Voltage Current Frequency	 100-240 VAC, +10, -15% 0.5 A @ 115 VAC, 0.3 A @ 240 VAC, typical 50/60 Hz, ±10%
BatteryType	User replaceable, 18V @ 3.5 AH ±10%, rechargeable NiMH pack
Battery Capacity	100 single-page reports (typical) or 6 hours continuous operation (without printing)
Battery Charge Time	Approximately 4.5 hrs. from total discharge with display off. NOTE: Cannot charge battery at or above 45° C (best if below 40° C)

Table B-6. Vectorcardiography	
Item	**Description**
Report Formats	Vector loops of component vectors (P, QRS, ST-T)
Sensitivity	20, 40, 80, 160 mm/mV
Time Resolution	2 ms

Table B-7. Hi-Res and PHi-Res Signal-Averaged Electrocardiography	
Item	**Description**
Frequency Response/Input	-3 dB @ 0.01 and 250 Hz
Frequency Response/Output Upper Limit Lower Limit	 250 Hz 0.01, 25, 40 or 80 Hz
Sensitivities Raw Data and Template Average Beat Filtered Signals and Vector Magnitude	 20 mm/mV 20 mm/mV and 50 mm/mV 1 mm/µV
Analysis Sampling Rate	1000 samples per second per channel
Digital Sampling Rate	4000 samples per second per channel
High/Low Pass Filters	Spectral filter using Fast Fourier Transform (FFT)
ADC Resolution	1.22 µV/LSB
Analysis Resolution	0.1525 µV/LSB

Table B-8. Physical *	
Item	**Description**
Height	9.4 cm (3.7 in) with display closed
Width	38.1 cm (15.0 in)
Depth	35.1 cm (13.8 in)
Weight	15 lb. without paper

*without trolley

Table B-9. Environmental	
Item	**Description**
Operating Conditions Temperature Relative Humidity Atmosphere Pressure	 10° C to 40° C (50° F to 104° F) * 20% to 95% RH noncondensing 700 to 1060 hPa
Transport/Storage Conditions Temperature Relative Humidity Atmosphere Pressure	 -40° C to 70° C (-40° F to 158° F)* 15% to 95% RH noncondensing 500 to 1060 hPa
Disposal Batteries Device	 Disposing of battery by fire or burning will cause the battery to explode. The battery is recycleable. Follow local environmental guidelines concerning disposal and recycling. Batteries may be returned to GE Marquette service for recycling. Recycleable.

*Paper discoloration may occur at higher temperatures.

Table B-10. Safety	
Item	**Description**
Certification	UL 2601-1 classified UL classified for CAN/CSA C22.2 No. 601.1 CB certified for IEC 601-1 CE marking for Council Directive 93/42/EEC concerning Medical Devices Meets applicable AAMI EC-11 requirements
Type of Protection Against Electrical Shock	Class 1, internally powered
Degree of Protection Against Ingress of Liquids	Ordinary
Handling of Disposable Supplies and Other Consumables	Use only parts and accessories manufactured or recommended by GE Marquette Medical Systems, Inc. Follow manufacturer's instructions for use for disposable/ consumable products. Follow local environmental guidelines concerning the disposal of hazardous materials.
Patient Mode of Operation	Continuous
Patient Leakage Current	<10 µA
Degree of Protection Against Electrical Shock	Type BF defibrillation protection for the patient cable (acquisition module)
Maintenance Frequency	Daily visual inspection and routine cleaning (if needed) performed by user. Use a commercially available, industrial strength disinfectant cleaner on any part of the equipment (other than electrodes) which comes into direct contact with the patient. Every six months routine maintenance checks and test procedures performed by qualified technical personnel.
Repair Guidelines	Calibration instructions, equipment descriptions, and all other information which will assist qualified technical personnel in repairing those parts of the equipment designated as repairable is available in the field service manual for the equipment. GE Marquette Medical Systems, Inc. will make available upon request circuit diagrams and component parts lists for printed circuit boards deemed repairable by qualified technical personnel.